LITERATURE ON GLOBAL WARMING

A BIBLIOMETRIC ANALYSIS
1992-2001

DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

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BY

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2002

Dedicated to

My

Loving Parents

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CERTIFICATE

This is to certify that '**Mr. Hayat Ahmad'**, bearing Roll No. 401 has completed his dissertation entitled "***Literature on Global Warming: A Bibliometric Analysis from 1992-2001***" in partial fulfilment of the requirements for the award of the Degree of **Master of Library and Information Science (2001-2002)**. He has conducted the work under my supervision.

S. Mustafa. K. Q. Zaidi

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Hayat

HAYAT AHMAD

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INTRODUCTION

'Global Warming' refers to an average increase in the Earth's temperature, which in turn causes changes in climate.

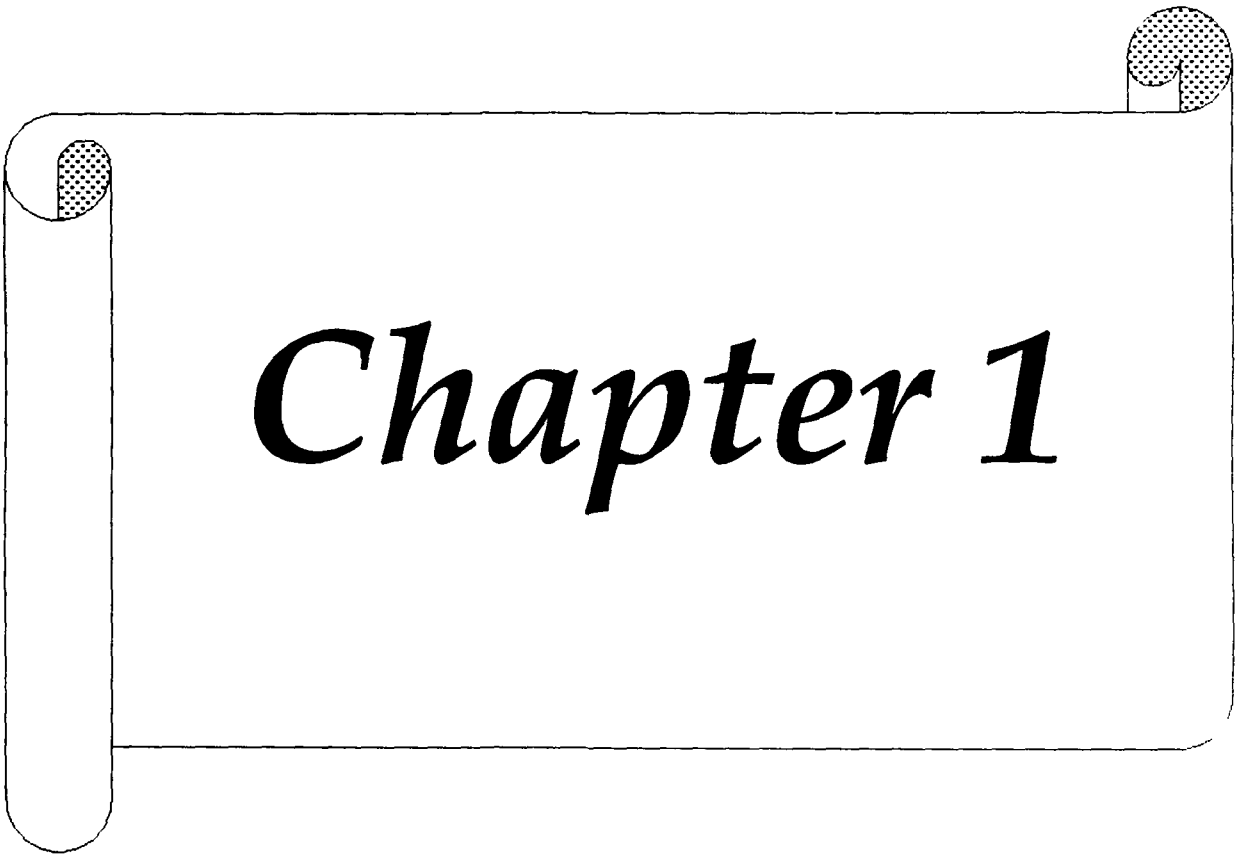
'Global Warming' being a major subject of research makes an important part of collection in any library. Moreover, this being an emerging field of research assumes special significance for the university library as books, journals, projects and research papers on this topic are quite considerable in number. Therefore, a Bibliometric study of the published material on this subject of the past 10 years was taken up.

In the quantitative analysis of the topic, I have tried to identify the core journals, frequency of the publications, productivity of the authors and language which is frequently used in the written document.

Citation counts are used in measuring the adequacy and organization of a library. Therefore, citation analysis forms second level of this dissertation where the citation of articles, authors, institutions and scientific activities are counted in order to identify the connection between the two documents and put them in order so that the users may find it more organized and easy to approach.

Hope this study will contribute in systematic analysis and organization of the recorded documents on *"Global Warming"* and its related aspects in the library and information centres.

The dissertation has been divided into four chapters. The 1st chapter deals with the theory of Bibliometrics and Citation Analysis. 2nd chapter covers the topic of study i.e. *"Global Warming"*. 3rd chapter is about Objective, Scope and Methodology of study. Data Analysis, Interpretation and Representation is the 4th part. Conclusions have been drawn as last part of the dissertation along with the findings.


Chapter 1

BIBLIOMETRICS

INTRODUCTION

The discipline that investigates the properties and behavior of information, the forces governing the flow of information and the means for processing information for optimal accessibility and usability is termed as "***Information Science***". Whereas information is the message conveyed by a systematized body of ideas or its accepted or acceptable substitutes.

After II World War, information explosion has been taking place. In the present age, librarians have been observing the ever growing number of bibliographic units like books, periodicals, articles in periodicals, corresponding increase in the size of library collection, number of catalogue cards, changes in search strategy and so on. This becomes all the more problematic because of the inelastic budgetary provisions. Realizing these factors, no single library can afford to acquire every document. Hence, limited and selected procurement of journals seems to be one of the practical remedies. Bibliometrics is relatively of recent origin. Bibliometric studies are conducted to identify the pattern of publications, authorship, and citations used for a subject etc. over a period of time and thereby offering insight into the dynamics of the area under a particular study.

1. BIBLIOMETRICS

Bibliometrics has been derived from the two words '***Biblion***' and '***Metric***'. The word 'Biblion' means **books** and "Metric' means **measurement**. So, Bibliometrics generally means '**measurement pertaining to books**'.

Bibliometrics is of recent origin and is a relatively new branch of information science. It lies between the border areas of the social science and the physical science. It has emerged as a research front in its own right in Information Science. It is now being vigorously pursued and with the result it has found that one-fourth of all the articles published in Library and Information Science periodicals are on Bibliometrics and its related topics.

The basic units of Bibliometrics are all facets of written communication such as primary and secondary periodicals, articles and abstracts published in them, bibliographies of articles, books, monographs and other media of communication.

1.1 ORIGIN AND HISTORY

First study regarding Bibliometrics was conducted in 1917 by **Cole**[1] and **Eales**[1] on the "*The History of Comparative Anatomy, Part –I:A Statistical Analysis*". First term used for this was "**Statistical Analysis**".

The second study done by **Hulme**[2] in 1923 used the term '**Statistical Bibliography**' and later it was used by **Henkle**[3] (1938), in his article "*The periodical literature of Bio Chemistry*", **Gosnell**[4] (1943), **Barker**[5] (1966) also used the same term i.e. '**Statistical Bibliography**'.

Gross and **Gross** study is considered to be the third in the field based on citations. In 1968 **Alan Pritchard** initially used the term '**Statistical Bibliography**" in his work but he analysed the term and found it could be

confused with '**Statistics**' itself or '**Bibliographies on Statistics**'. Therefore he coined another term i.e. "**Bibliometrics**" in **1969**.

1.2 RELATED TERMS

The term Bibliometrics is of very recent origin. In 1948, the great Indian library scientist, **Dr. S. R. Ranganathan,** coined the term **LIBRAMETRY** which historically appeared first, perhaps seemed proper to streamline the service of librarianship. The term 'Bibliometrics' is just analogous to Ranganathan's **LIBRAMETRICS,** the Russian concept of **'SCIENTOMETRICS',** FID's **INFORMETRICS** and to some other well established sub discipline like **ECONOMETRICS PSYCHOMETRICS, SOCIOMETRICS, TECHNOMETRICS, CHEMOMETRICS,** etc. where mathematical & statistical calculus have been systematically applied to study and solve problems in their respective fields. Now-a-days, the term **'SCIENTOMETRICS'** is used for the application of quantitative methods to the history of science and obviously overlaps with bibliometrics to a considerable extent.

So we can say that bibliometrics is a methodological sub discipline of library science including the complex of mathematical and statistical methods, used for analysis of scientific documents and nonscientific documents.

1.3 DEFINITIONS

Many attempts have been made to define the term Bibliometrics, as given below –

Hulme (1923)[8] **:** The purpose of statistical Bibliography is to "shed light on the process of written communication and of the nature and course of

development of a discipline by means of counting and analysis of various facets of written communication"

Raising (1962)[9] : "The assembling and interpretation of statistical data relating to books and periodicals , to demonstrate historical movements, to determine national and universal research, use of books and journals and to ascertain in many local situation the general use of books and journals"

Pritchard (1969)[10] : "The application of mathematical methods of books and other media of communication"

Fairthorne (1969)[11] : " Bibliometrics is the quantitative treatment of properties of recorded discourse and behavior appertaining to it"

Hawkins (1977)[12] : "Bibliometrics is the quantitative analysis of the bibliographic feature of a body of literature"

Potter (1981)[13] : "Bibliometrics is the study and measurement of the publication patterns of all forms of written communication and their authorship"

Schrader (1981)[14] : "Bibliometrics is the scientific study of recorded discourse"

Broadus[15]: "Bibliometrics is the quantitative study of physical published units or of bibliographic units of Surrogates of either"

Sengupta[16] : "Organisation, classification and quantitative evaluation of publication patterns of all macro and micro communication along with their authorship by mathematical and statistical calculus"

British Standard Glossary of Documentation of Terms[17] : "The use of documents and patterns of publication in which mathematical and statistical

methods have been applied ". This definition is basically similar to **Pritchard's** original definition.

2. BIBLIOMETRICS: SCOPE

Nicholas and **Richie** in 1978 very "Lucidly elaborated the scope of bibliometrics. They opined that bibliometrics provide information about the structure of knowledge, and how it is communicated". They further added that 'Bibliometric' studies fall mainly into two broad groups:-

A) Descriptive Studies i.e. those describing the characteristic or features of a literature.

B) Behavioural Studies i.e. those examining the relationship formed between components of literature.

While defining the scope of 'Bibliometrics', **Doniel Conner** and **Henry Voos** add that the "scope of Bibliometrics includes studying the relation within the literature typically these descriptions focus on consistent patterns, involving authors, monographs, journals or subject language". **Rolland Stevens** considers Bibliometrics as quantitative science and divides it into two basic categories viz.

Descriptive Bibliometrics and Evaluative Bibliometrics. He has further divided these two areas into different sub areas as given below:-

A) Descriptive Bibliometrics

-- Geographic

-- Time Period

-- Discipline

B) Evaluative Bibliometrics

-- Citations Count

-- Reference Count

Stevens further adds that descriptive bibliometrics includes the "study of the number of publications in a given field or productivity of literature in the field for the purpose of comparing the amount of research in different countries, the amount produced in different subdivisions of the field. The kind of study is made by a count of papers, books and other writing in the field or often by a count of those writings, which have been abstracted, in specialized abstracting journals. The other i.e. evaluative bibliometrics includes the study of the literatures used by the research workers in a given field. Such a study is often made by counting the references cited by a large number of research workers in their papers".

2.1 PURPOSE

Pritchard in 1969 assigned its purpose as to shed light on the process of written communication and of the nature and course of development of a descriptive means of counting and analyzing the various facets of written communication.

According to **Dr. S. N. Singh** "The purpose of bibliometrics is to provide quantitative analysis of the phenomenon going with documents, their organization, use and services in Library and Information Centre and Systems. It offers to the information worker a type of statistical technique for the study of characteristics and attributes of literature and that of communication media".

The main purpose of Bibliometrics study is:-

- To find out major forms of literature.
- To prepare a ranked list of journals.

- To make a comparison between ranked journals.
- To identify the country with greatest literary output.
- To find out the chronological scattering of cited literature.
- To ascertain the amount of utilization of language.

Some other purposes are:-

- To develop norms and standardization.
- To regulate inflow of information and communication.
- To identify authorship and its trends in documents of different subjects.
- To measure useful news of adhoc and retrospective SDI service and so on.

2.2 APPLICATION OF BIBLIOMETRICS

Bibliometrics techniques are now being consistently used to get factual and accurate data for information handling and transfer. Enumerated below are some of the areas where Bibliometrics techniques may be used:

- To study quantitative growth of a discipline and its literature quantitatively.
- To evaluate the growth of research of an individual, of an institution or of a country.
- To assess the research output i.e. productivity study of an individual scientist, an entire Organisation or of a country.
- To undertake Sociological Studies of science and scientists.
- To study past, present and predicts future of scientific classics.
- To estimate comprehensiveness of secondary periodicals.
- To regulate inflow of information and communication.
- To develop norms of standardization etc.

- To find out core journals by applying Bradford's Law.
- To find out the productivity of scientist by applying Lotka's Law.
- To study the use of literature from different countries.
- To study the scattering of subject.
- To find out the relative use of different languages.
- To study the rate of collaborative research.
- To find out the trends in research activities.

2.21 APPLICATION IN INDEXING

Bibliometrics studies have been made in the areas of Library & Information work also. Studies have been made to find out the pattern of frequency distribution of descriptors of a thesaurus and the distribution of indexing terms. **Eugenics Toma** analysed the rank-frequency distribution of the EURATOM Thesaurus. Zipf's Law essentially a hyperbolic function, was not found suitable for such distribution. On the other hand a exponential function was found in good agreement with the actual entropy of the thesaurus. This exponential function may provide a criterion to revise some zones of thesaurus.

2.22 APPLICATION IN LIBRARY MANAGEMENT

It has been said that bibliometrics studies should ultimately help in library management. It is true that knowledge of scattering and obsolescence can be utilized in the acquisition and management of stocks. But there is much more scope for investigation. Such investigations have been shown by **A. D. Booth** while considering the optimum physical layout of a library when it is desired to minimize the distance to be traveled by the reader while picking up the books from the shelves. This means books are to be arranged

according to their frequency of use. Several interesting geometrical models of stacks have been suggested by Booth, It is claimed that frequency ordered arrangement can lead to increased efficiency by as much as ten times.

2.23 UTILITY OF BIBLIOMETRICS IN RESEARCH

At present, bibliometrics work often provides the background for a more practical task. It is an established technique covering wide area of knowledge. It has therefore been able to involve scholars from many of these disciplines. Consequently it has attracted scholars from different disciplines or their respective fields. Day by day, it is attaining sophistication and complexity having national, international and interdisciplinary character. It has established itself as a variable and distinctive research technique for studying science of science based on bibliographic data. As a matter of fact, its backbone lies in its sound theoretical foundation most efficiently and effectively laid by some pioneers like **Gross, Lotka, Bradford, Zipf, Derek J. De Solla Price, Bookstein, Massavesik, Cole Brother, Pritchard, Garfield Hulme, Fairthorne** and many others who are all not basically librarians, but belong to different branches of knowledge.

The techniques evolved by these pioneers are capable of throwing light on various complicated problems faced by many while handling information to quantify the process of written communication. It has established itself as a viable and distinctive measurement of human knowledge. Data analysis both of citations and of volume of publications year by year can be useful in planning retrospective bibliographies.

Bibliometrics also provides information about the structure of knowledge. Its classification studies give information about the subject,

language and country relationship, which is based on literary warrant. Bibliometrics is very useful in any field of research or in any discipline or it can be used in small and manageable ways by individuals, to improve some part of library or information service.

3. BIBLIOMETRIC LAWS

There are three fundamental laws which laid the solid foundation of bibliometrics:

1) Lotka's Inverse Square Law of Scientific Productivity (1926)

2) Bradford's Law of Scattering of Scientific Papers (1934) ; and

3) Zipf's Law of Word Occurrence (1949)

3.1 LOTKA'S INVERSE SQUARE LAW

This law was put forth by **Alfred J. Lotka** in 1926. It relates to the productivity of scientists in terms of number of papers published by them. He was interested in determining, "If possible the part which men of different caliber contribute to the progress of science"

Lotka studied the productivity of authors by publication frequency as indicated in **Chemical Abstracts** from 1907 to 1916. Similarly, he studied the name index of **'Auerbach's Geschietftafeln der physik'**. It revealed that the productivity of the scientists confirmed to inverse square law, such that for every 100 authors contributing one article, 25 will contribute 2 articles, 11 will contribute 3 articles and 6 will contribute 4 articles, and so on. The observed figures for single article authors were 57.9 percent for Chemical Abstract data (6,891 contributors) and 59.2 percent for the Physics data (1,325 contributors).

The frequency distribution of productivity of authors of scientific papers was first studied by Lotka, who proposed that the number of authors making 'n' contributions is about $\mathbf{1/n^2}$ of those making one contribution, and the proportion of all contributors who make a single contribution is about 60 percent, or $\mathbf{n(n) = k/n^2}$.

Where 'a' is the number of authors producing n papers and 'k' is a constant.

The original paper of Lotka gave no suggestion to show that this was a universal law with applicability to all branches of knowledge, or even for that matter, to all the branches of science. Subsequent studies have shown that this law is applicable to the subjects of History, Technology, Science, Literature etc.

3.2 BRADFORD'S LAW OF SCATTERING

Of all the Bibliometric Laws, Bradford's Law has received greatest attention in the literature of Library and Information Science. Bradford's law of scattering was promulgated by the British bibliographer Samuel Clement Bradford. Bradford's concern was with the problem of seepage and scattering of articles of articles in primary journals and their coverage in indexing and abstracting sources.

Much earlier, he described the pattern of scatter of literature in a subject in various periodicals, in a paper on applied Geo-physics and Lubrication. In this study he found out that 9 journals covered 429 articles and the next 59 journals accounted for 499 articles, in other words first nine journals contributed for one-third of the articles found on the subject, the next 5×9 journals accounted for another one-third, and the next 5×9×9 journals for

the remaining one-third. In other words periodicals can be categorized in three separate groups as under:-

1) Those periodicals which carry four references in a year, in a given subject.

2) Those which carry between two and four in a year.

3) Those which carry one or fewer references in a year.

The first group thus becomes the nucleus of periodicals in a subject and necessarily contains more articles on that subject and necessarily contains more articles on that subject rather than periodicals that cover articles on related subjects.

On the basis of above study Bradford enunciated "If scientific periodicals are arranged in the order of decreasing productivity of articles on a subject, that may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones containing the same number of articles as the nucleus when the number of periodicals in the nucleus and succeeding zones will be **1: n: n^2** ".

Where 'l' is the number of journals in the nucleus and 'n' is a multiplier.

The refinement of law has been made by B.C. Vickery. He found discrepancy between the verbal and graphical representations of Bradford's law. He pointed out that application of the Bradford's law should not only be limited to three zones, but with suitable modification of the value of ratio n, to any number of zones.

3.3 ZIPF'S LAW OF WORD OCCURRENCE

This law was given by George K. Zipf in 1949. Zipf's law states that "in a long textual matter if words are ranked on the basis of their frequency, then

rank of any given word of the text will be inversely proportional to the frequency of occurrence of the word".

i.e. $f \propto 1/r$

or $f \times r = C$

Where 'C' is constant.

He found that by multiplying the numerical value of each rank (r) by its corresponding frequency (f) he obtained product (C) which is constant throughout its text.

Example:

In any textual part, certain words are picked up

Word	Rank (r)	Frequency(f)	f × r
The	1	245	245
An	2	136	272
A	3	100	272
To	4	81	324
Are	5	66	330

Thus, these three laws are respectively based on

i) Number of authors contributing in a discipline or other fields.

ii) Distribution of articles in a set of journals.

iii) Ranking of word frequency in a particular set of documents.

3.4 SOME OTHER EMPIRICAL LAWS

3.4.1 PRICE'S SQUARE ROOT LAW OF SCIENTIFIC PRODUCTIVITY

This law was given by Derek J. de Solla Price in 1971. This law states that "half of the scientific papers are contributed by the square root of the total number of scientific authors".

3.42 GARFIELD'S LAW OF CONCENTRATION

This law was enunciated by Eugene Garfield in 1971. This law states that "a basic concentration of journals is the common core of nucleus of all fields".

3.43 SENGUPTA'S LAW OF BIBLIOMETRICS

This law has been put forward by I. N. Sengupta in 1973 which is also known as off setting weightage formula for re-ranking periodicals to avoid discrimination against new journals which necessarily have citation credits. This is basically an extension of the Bradford's law.

It states that "during phases of rapid growth of knowledge in a scientific discipline, articles of interest to that discipline appears in increasing number of periodicals distant from that field".

Mathematically this law stands in the following form:

$F(X + Y) = a + b \log (X+Y)$

Where f(X+Y) is the cumulative number of references as contained in the first (X+Y) most productive journals, X indicates number of journals in the same discipline and y stands for number of journals of unrelated disciplines (Y>X) and 'a' and 'b' are two constant.

4. SUBDIVISIONS OF BIBLIOMETRICS

4.1 Operation Research (Linear Programming, Transport problems)

4.2 Statistics (Mutivariable Techniques, Trends, Correlations)

4.3 Bibliometric laws (Laws of Zipf, Lotka and Bradford)

4.4 Citation analysis (Networks, Science Policy)

4.5 Circulation Theory (Models)

4.5 Information Theory

4.7 Theoretical Aspects of Information and Retrieval.

5. CITATION ANALYSIS

Citation analysis is the area of bibliometrics that studies the citations and from documents. It is a research method that can focus on the documents themselves, on the authors, or the journals and other publications in which they appear. Simply put, citation analysis can provide a picture of "where the action is" in a discipline. By gathering and analyzing citation statistics, who's writing what, what subjects are popular, which journal and authors are cited most, and by extension, considered the most influential.

The primary function of citation is to provide "a connection between documents, one which cites and other which is cited". There are umpteen number of reasons for giving citations. **Weinstock, Lipetz, Moravcsik and Murugesan, Hodges, Oppenheim and Renn, Finney, Frost and Thorne** have all attempted to explore the possible reasons for giving citations. They include the positive and negative reasons for inclusion. However, it has to be conceded that if the reason is positive there is bound to have some connection between the citing and cited papers. The first recorded citation analysis was a study by P.L.K. Gross and E. M. Gross published in 1927 in order to determine the journals to be subscribed to and the back volumes to be acquired for the Library of the Pomona college. They studied the citation frequency in the references given in the *Journals of the American Chemical Society*. Citation analysis is very often fruitfully applied to derive the following benefits:

(a) To lead the reader to further studies in the field:

This is perhaps, the primary purpose of citations. Readers can verify the correctness of the information and thereby convince themselves.

(b) For the preparation of Bibliographies:

This use of citation indexing was made in Shepherd's citations published in 1873. This technique of citation indexing has been prepared by E. Garfield and others since early 1960s. It is a fact that compilation of bibliographies in new fields is really difficult. In such circumstances, analysis of citations of articles may be the only way to gather information. The very fact that the citations have been verified, evaluated and recommended by authors who are experts in their own fields make them all the more acceptable for inclusion in a bibliography.

(c) To study the use pattern of different types of documents: -

Citations given may be of books, journals, articles, reports standard, thesis/dissertations etc. The relative use of each of these types can be ascertained based on the frequency of citations. For example, various citation studies have shown that the journal articles are the most preferred source consulted by scientists since they constitute about 70-80% of the total citations. Similarly citation practices among social scientists indicate that they give equal importance to books and journals.

(d) To find out the relative use of different languages:

Since English has emerged as a world language, especially in science and technology, there is a predominance of English language publications in all branches. This can easily be understood from citation analysis. In the mid-sixties, for instance the share of English language papers in Mathematics and Chemistry was more than 50% Russian occupied the second position with

about 20% followed by German and French Citation practices have also shown that the relative amount of literature in different subjects produced by different countries changes with time It has been observed that German has declined very much in the 20th century, especially in the field of chemistry where publications in this language reigned supreme.

(e) To study the use of literature from different countries:

From the citations, the country of their origin can be identified in all types of materials like journal articles, books, reports etc. In many subject areas, US publications are found to be used more heavily. Journals of UK occupied the second position, but they come nowhere near their American counterparts in the frequency of use.

(f) To study the scattering of subjects:

Studies about the dispersion or scattering of subjects in different sources as evidenced by citation analysis have brought out interesting results, for e.g.

(i) Social science and arts subject show a wider scatter of publications than the sciences.

(ii) Research publications in technology show a greater dispersion than those in science.

(iii) A new branch of science, especially an interdisciplinary one, shows grater dispersion than an older branch of science.

(iv) There can be differences in scatter between sub-fields within a subject as also among major subjects.

(v) The rate of scatter within the same subjects alters with time.

(g) To decide the obsolescence rate of documents in different subjects:

Citations in subsequent literature and usage pattern in libraries are considered as two indication of the obsolescence rate of literature. Analysis of citations by age of the cited document can show the useful life of document. In order to measure the decay or obsolescence of documents. The concept of half-life has been borrowed from Nuclear Physics. The above study had shown the half-life of Metallurgical Engineering as 3, while that of Botany is 10 years. These time scales are highly useful in the planning of library holdings.

(h) To determine the interdependence and lineage of subjects:

The interdependence of basic and applied fields can be understood by citation studies. Establishment of this interdependence can be of use in the acquisition policy of special libraries or information centers. The analysis of citations of the Annual Review of Medicine for the year 1965-69 by I.N. Sengupta, has established the contribution made by journals in the fields of biochemistry and physiology to the medical research. Further studies by him have brought to light the mutual contribution of biochemistry, physiology and microbiology.

As far as lineage of subjects are concerned, Garfield's experiments in citation indexes have very much contributed in mapping the history of many of them.

(1) To prepare ranked list of periodicals.

(2) To study the rate of collaborative research.

(3) For the analysis of scientific journals.

(4) Citation rate of journals.

(5) Impact factor.

(6) Self-citing rate.

(7) Self-cited rate.

(8) Immediacy index.

6. LIMITATION IN APPLICATION

Though most of the studies tends to support the Bradford distribution some other researchers could not get the satisfactory results. Gross found that the scatter of research papers among physics deviated from that predicted by Bradford's law. Out of 50 bibliographies studied by Chonez, only six followed the law, he calls it as the "**Pseudo Scientific Law**".

6.1 LOTKA'S LAW

In the case of Lotka's law it was found to fit in the most cases. However, the value of indexing was found to vary for different groups of scientists.

Another problem with Lotka's law is that it totally ignores the potential authors who have not produced any publication so far.

6.2 CITATION ANALYSIS

In case of citation analysis, the common arguments against it are as follows:

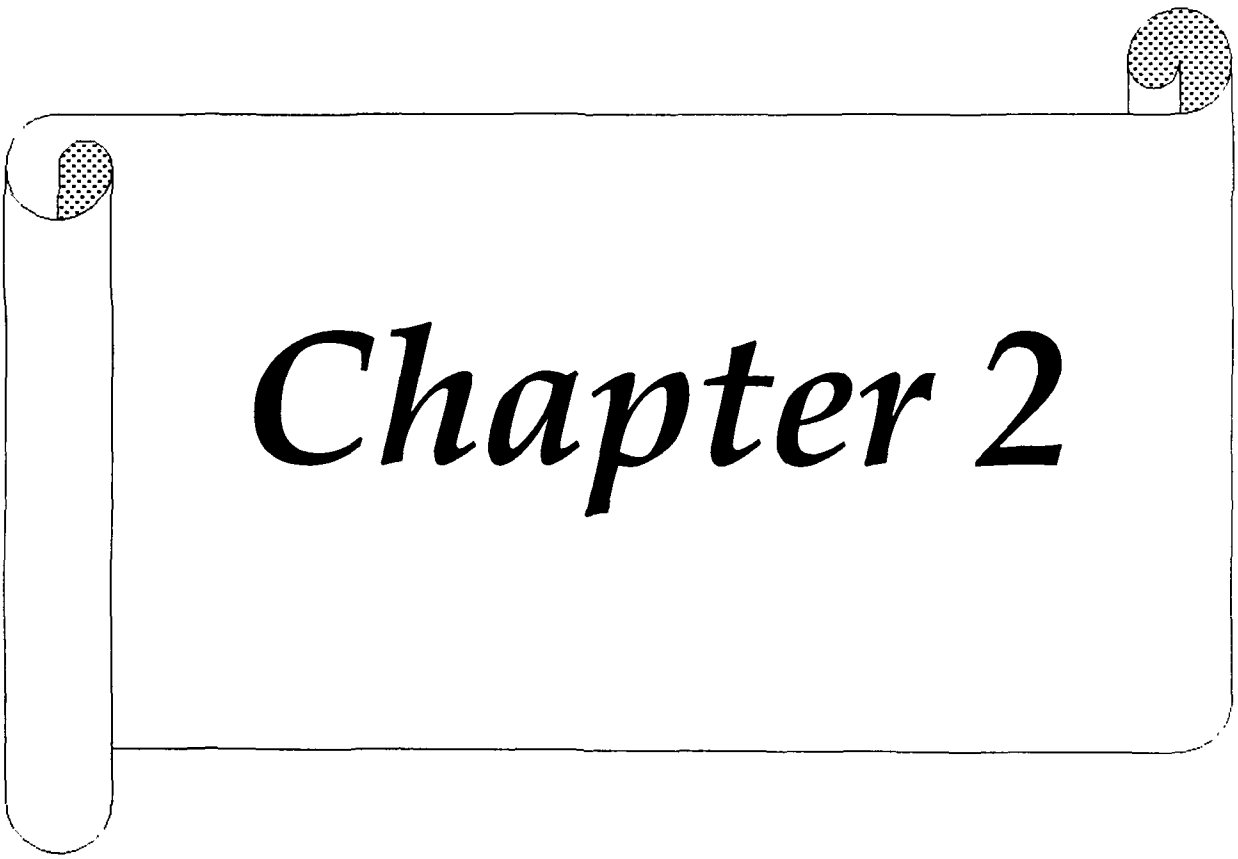
- Too much of self-citation and in-house citation.
- Practice or citing only to get the favours of the powerful or to appease others.
- Citation given just to dress up the paper.
- Variation of citation rate during lifetime of paper.

- Variation of citation rate with type of paper and speciality
- Negative citation

Because of all these limitations the empirical nature of these laws are generally questioned

CONCLUSION

Bibliometrics studies have enabled to develop a body of theoretical knowledge and a group of techniques and have facilities its application for the further growth of knowledge based on bibliographical data Bibliometrics has contributed greatly to the development of library and information science The subject is still at a developmental stage and there is a great possibility of bibliometrics studies in various aspects of library and information work Bibliometrics has emerged as the most active field of Library and Information Science during the past few decades It is estimated that literature on this topic occupies more than 25% of the total contribution in Library and Information Science Citation Analysis studies form a major portion of it, pertains to the application of bibliometric laws However, there is a long way to go in achieving perfection in the studies Even the spread of computers for retrieval, counting and analysis are unlikely to achieve perfection in the studies This study is merely a method not a theory To make it a theory and more useful, researchers must concentrate on the causal factors underlying bibmetrics phenomena The changes that are frequently occupying in the publication practices are likely to complicate the studies in future In such circumstances it is advisable to consider the results of such studies as merely guidelines rather than ends in themselves


Chapter 2

GLOBAL WARMING

Global warming refers to an average increase in the Earth's temperature, which in turn causes changes in climate. A warmer Earth may lead to changes in rainfall patterns, a rise in sea level, and a wide range of impact on plants, wildlife, and humans. When scientists talk about the issue of climate change, their concern is about global warming caused by human activities.

Global temperatures are rising. Observations collected over the last century suggest that the average land surface temperature has risen 0.45-0.6°C (0.8-1.0°F) in the last century. Since 1979, scientists have generally agreed that a doubling of atmospheric carbon dioxide increases the earth's average surface temperature by 1.5-4.5°C (3-8°F). More recent studies have suggested that the warming is likely to occur more rapidly over land than the open seas. Rainfall Precipitation has increased by about 1 percent over the world's continents in the last century. High latitude areas are tending to see more significant increases in rainfall, while precipitation has actually declined in many tropical areas. The warmer temperatures are expected to raise sea level by expanding ocean water, melting mountain glaciers, and melting parts of the Greenland Ice Sheet. Sea level has raised worldwide approximately 15-20 cm (6-8 inches) in the last century. Approximately 2-5 cm (1-2 inches) of the rise has resulted from the melting of mountain glaciers. Another 2-7 cm

has resulted from the expansion of ocean water that resulted from warmer ocean temperatures. The temperatures of the Earth and any other planet depend mainly on

(1) The amount of sunlight received;

(2) The amount of sunlight reflected into space; and

(3) The extent to which the atmosphere retains heat.

The extent and speed at which humanity changes the climate will depend to a large extent on the rate at which society adds additional greenhouse gases to the atmosphere.

CLIMATE CHANGE

Earth's climate has been changing constantly over its 5-billion-year history. Sometimes, the climate has warmed so that the oceans have risen and covered much of the Earth. Each of the changes may seem extreme, but they usually occurred slowly over many thousands of years. Changing Climate Global mean surface temperatures have increased 0.5-1.0°F since the late 19th century. The 20th century's 10 warmest years all occurred in the last 15 years of the century. Of these, 1998 was the warmest year on record. The snow cover in the Northern Hemisphere and floating ice in the Arctic Ocean have decreased. Globally, sea level has risen 4-8 inches over the past century. Worldwide precipitation over land has increased by about one percent. The frequency of extreme rainfall events has increased throughout much of the United States.

Increasing concentrations of greenhouse gases are likely to accelerate the rate of climate change. Scientists expect that the average global surface temperature could rise 1-4.5°F (0.6-2.5°C) in the next fifty years, and 2.2-10°F

(1.4-5.8°C) in the next century, with significant regional variation. Evaporation will increase as the climate warms, which will increase average global precipitation. Soil moisture is likely to decline in many regions, and intense rainstorms are likely to become more frequent. Sea level is likely to rise two feet along most of the U.S. coast. Calculations of climate change for specific areas are much less reliable than global ones, and it is unclear whether *regional climate will become more variable.*

CLIMATE HISTORY

1) Ancient Climate History

The first people arrived in America between 15,000 and 30,000 years ago. During that time, much of North America was covered by great ice sheets. Some 14,000 years ago, the last ice sheet began to melt very quickly. By 7,000 years ago, the ice was gone. This end to the ice ages caused big changes on the Earth. The changes caused many kinds of plants and animals to die. For example, mastodons, elephant-like animals and other large mammals that preferred cold climates may not have been able to live in the warmer, drier conditions.

2) The Little Ice Age

Starting in the 14th century, Europeans lived through what is known as the "Little Ice Age." The Little Ice Age lasted for several hundred years. During the Little Ice Age, the advance of glaciers along with hard winters and famines caused some people to starve and others to leave their homes.

3) Recent Climate History ✓

The Earth has warmed about 1°F in the last 100 years. And the four warmest years of the 20th century all happened in the 1990s. Periods of increased heat from the sun may have helped make the Earth warmer. But many of the world's leading climatologists think that the greenhouse gases people produce are making the Earth warmer. Some scientists think the glaciers are melting partly because the Earth is getting warmer and because of that the level of the sea is rising, so high tides are higher than they were before. Over the last 100 years, the level of the sea has risen about 6-8 inches worldwide. When the sea level rises, the tide goes farther up the beach. Scientists think the sea has risen partly because of melting glaciers and sea ice. When some glaciers melt, they release water into the sea and make it higher than it was before. Scientists also think that warmer temperatures in the sea make it rise even more. Heat makes water expand. When the ocean expands, it takes up more space.

CAUSES OF GLOBAL WARMING

1) Greenhouse Effect

There is a natural greenhouse effect which keeps the earth warm enough average temperature about 60°F) to be habitable. Greenhouse gases like carbon dioxide, methane, nitrous oxide, and water vapor trap heat and warm the earth's surface. Exactly how the earth's climate responds to enhanced greenhouse gases depends on complex interactions between the atmosphere, oceans, land, ice and biosphere. Atmospheric concentrations of greenhouse gases have increased significantly since the Industrial

Revolution: carbon dioxide +30%; methane +100%; nitrous oxide +15%. Many greenhouse gases remain in the atmosphere for a long time (decades to centuries). Projected CO_2 concentration levels are significantly higher than any observed over the past 160,000 years.

2) Greenhouse Gases

Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases.

Carbon dioxide is released to the atmosphere when solid waste, fossil fuels (oil, natural gas, and coal), wood and wood products are burned. Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from the decomposition of organic wastes in municipal solid waste landfills, and the raising of livestock. Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of solid waste and fossil fuels. Very powerful greenhouse gases that are not naturally occurring include hydro fluorocarbons (HFCs), per fluorocarbons (PFCs), and sulfur hexafluoride (SF6), which are generated in a variety of industrial processes.

Each greenhouse gas differs in its ability to absorb heat in the atmosphere. HFCs and PFCs are the most heat-absorbent. Methane traps over 21 times more heat per molecule than carbon dioxide, and nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide. Often, estimates of greenhouse gas emissions are presented in units of millions of

metric tons of carbon equivalents (MMTCE), which weights each gas by its GWP value, or Global Warming Potential.

The Greenhouse Carbon dioxide is the principal global warming pollutant. Its concentration has increased more than 30 percent since 1750, and is expected to continue climbing as long as emissions increase. The predicted increase could alter the global environment in dangerous ways, including:

- An average temperature increase of six degrees Fahrenheit by 2100
- An increase of severity and frequency in heat waves, droughts, and other extreme weather events
- A global sea level rise of as much as three feet by 2100
- An increase in the range of disease-carrying insects and rodents unless emissions of global warming pollutants are reduced, the Earth could warm up at a rate faster than it has in the past 10,000 years. Increased temperatures could affect the environment, human health, social systems, and the global economy in ways never before experienced.

3) Deforestation (Forest Destruction)

Destruction of biotic potential of lands leads to deforestation. Such problem arises due to over-grazing, indiscriminate felling of trees and over-exploitation of land resources. Deforestation has a major impact on the productivity of croplands. This happens in two ways:

1) Soil erosion increases manifold and the soil actually gets washed, leading to an accentuated cycle of floods and drought.

2) But equally important is the impact of the shortage of firewood on the productivity of our croplands.

Deforestation and over-grazing have been causing tremendous land erosion and landslide.

Apart from all this, deforestation is also a telling cause of Global Warming as it decreases the Oxygen level and increases Carbon Dioxide's level, which is one of the main greenhouse gases. Forest fire is also a big worry for the ecological balance and makes a way for deforestation.

According to the data from World Resources Institute (1990), deforestation contributes 14% to Global Warming out of the total of different types of human activities.

4) Industrial Processes

After the industrialization, modern man has changed the way he lived earlier and changed the means to do his daily routine jobs, big factories with their furnances and chimneys produce lots of air pollutants such as CO_2, carbon monoxide, etc and it has a telling effect on the increase of Earth's mean temperature.

According to the data from World Resources Institute, Industrial Processes contribute 24% to the total by human activities in 1990.

Contribution to 'Global Warming'

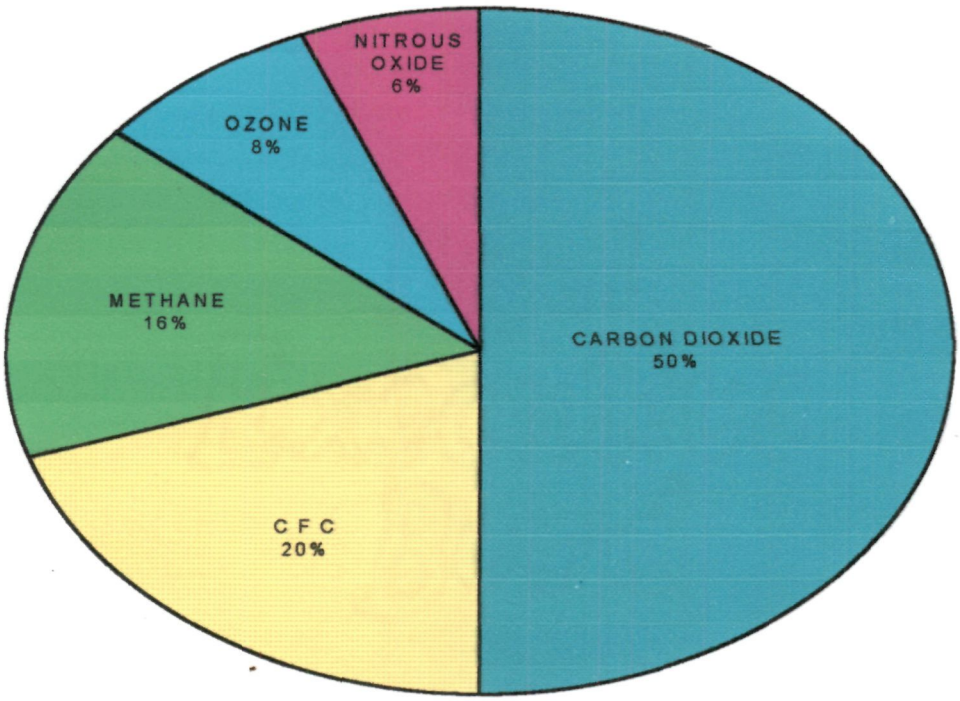


Figure: Relative contribution to 'Global Warming' anthropogenic (human caused) release of gases in to the atmosphere.

Sources: World Resources Institute and the United Nation Environment Programme

FALL OUTS OF GLOBAL WARMING

1) Human Health

Climate change may affect people's health both directly and indirectly For example, heat stress and other heat related health problems are caused directly by very warm temperatures and high humidity Untreated heat stress can be a very serious medical problem Scientists suspect that in many places, global warming will increase the number of very hot days that occur during the year More hot days increases the possibility of heat related health problems

Indirectly ecological disturbances air pollution changes in food and water supplies, and coastal flooding are all examples of possible impacts that might affect human health How people and nature adapt to climate change will determine how seriously it impacts human health Some people and places are likely to be affected more than others Generally poor people and poor countries are less likely to have the money and resources they need to cope with preventing and treating health problems Very young children and the elderly adults will run the highest risks

2) Ecological Systems

Climate change may alter the world's habitats and ecosystems, all living things are included in and rely on these places Many of these places depend on a delicate balance of rainfall temperature, and soil type A rapid change in climate could upset this balance and seriously endanger many living things Most past climate changes occurred slowly allowing plants and animals to adapt to the new environment or move somewhere else However

if future climate changes occur as rapidly as some scientists predict, plants and animals may not be able to react quickly enough to survive The ocean's ecosystems also could be affected for the same reasons.

3) Sea Level Rise

Global warming may make the sea level become higher as warmer weather makes glaciers melt. A glacier is a large sheet of ice that moves very, very slowly. Some melting glaciers add more water to the ocean. Warmer temperatures also make water expand. When water expands in the ocean, it takes up more space and the level of the sea rises. Sea level may rise between several inches and as much as 3 feet during the next century. This will effect both natural systems and manmade structures along coastlines. Coastal flooding could cause saltwater to flow into areas where salt is harmful, threatening plants and animals in those areas. For example, an increase in the salt content of the Delaware and Chesapeake bays is thought to have decreased the number of oysters able to live in those waters. Oceanfront property would be affected by flooding, and beach erosion could leave structures even more vulnerable to storm waves. Whether we move back from the water or build barricades in the face of a rising sea, it could cost billions of dollars to adapt to such change Coastal flooding also may reduce the quality of drinking water in coastal areas.

4) Islands

Because of Global Warming the sea level is shooting up day-by-day and if this trend continues for the next 50-100 years or so then many islands (like Maldives, Caribbean and New Zealander) will not be mapped in the world map as they will be drowned into the oceans. And if it happens then a large

number of migrations will follow which again poses a great ecological problem.

5) Crops and Food Supply

Global warming may make the Earth warmer in cold places People living in these places may have a chance to grow crops in new areas. But global warming also might bring droughts to other places. In some parts of the world, people may not have enough to eat because they cannot grow.

6) Species

Each 1°C of warming will shift temperature zones by about 100 miles northward (or 500 feet in elevation). Many plant and animal species will be unable to migrate fast enough to find suitable habitats An increase of 3°C could threaten 7-11% of North America's plant species. Northern limits of many birds are strongly associated with climate. Scientists estimate that there will be a loss of cold-water fish habitat of 1.7-2.3 million acres by 2060.

THE CLIMATE DETECTIVES

In order to investigate the clues to find evidence – real facts. Here are some of the ways that criminologists gather evidence about climate and temperature, both past and present:

1) Weather Stations

Weather stations help to find out the temperature on the surface of the Earth. Weather stations use special thermometers that tell about the temperature. They can be set up almost anywhere on land. Weather stations

also can tell how fast the wind is moving and how much rain falls on the ground during a storm.

2) Weather Balloons

Weather balloons are released to float high up into the atmosphere. They carry special instruments that send all kinds of information about the weather back to people on the ground.

3) Ocean Buoys

A buoy is an object that floats on water, and is often used to warn boats away from dangerous places in the ocean or on a river. But some buoys have special instruments on them. These buoys can tell the temperature and other things about the conditions of the atmosphere.

4) Weather Satellites

Humans send satellites into space to travel around the Earth. The satellites send back information to scientists on the ground. Some of the information they give is about the weather and the Earth's temperature.

5) Ice Cores

Some scientists who want to find out more about climate study ice for clues. Not just any ice, they are studying the ice from glaciers that have been around for a very long time. They cut pieces of ice and look for air bubbles that were trapped in the ice hundreds or even thousands of years ago. The air bubbles help them discover what the climate used to be like on Earth. The evidence they uncover is creating a historical record of regional temperatures and greenhouse gas concentrations dating back 160,000 years.

6) Sediment Analyses

Sediment is the earth and rock that has built up in layers over time. Scientists are learning a great deal about past climate from studying these layers. Sediment layering provides information about where glaciers have been in the past. Ocean sediments provide a map of how ocean currents have flowed in the past. And fossilized pollen found in sediment layers tells us about where different plants have grown in the past.

7) Tree Rings

Tree rings also used to study how much precipitation fell each year in the place where the tree lives and tell how old a tree is by counting its rings because it grows a new ring every year. Precipitation is rain or snow or any other moisture that falls to the Earth. Scientists study the sizes of tree rings. The different sizes of the rings tell about changes in temperature and precipitation.

GLOBAL WARMING TIMELINE (1896 – 2001)

In 1896, Swedish chemist Svante Arrhenius predicts a connection between rising atmospheric carbon dioxide concentrations and potential impacts on the global climate system.

In 1957, Revelle and Seuss, scientists at the Scripps Institute of Oceanography, report for the first time that much of the carbon dioxide emitted into the atmosphere is not absorbed by the world's oceans, as some had argued.

In 1979, A National Academy of Sciences panel on climate change advises that in order to avoid significant climate changes, "A wait-and-see policy may mean waiting until it is too late "

In 1988, The United Nations creates the Intergovernmental Panel on Climate Change (IPCC), an international conference of scientists, to address the issue of global warming, its environmental, economic and social impacts, and possible national and international responses

In1988, Dr. James Hansen of the NASA Goddard Institute for Space Studies testifies before the Senate Committee on Energy and Natural Resources that the Earth in 1988 is warmer than at any time in recorded history.

In 1990, The IPCC's First Assessment Report is released The report drawing on the work of 170 scientists from 25 countries is meant to represent the definitive scientific statement on global warming to date Among other things, the report states that global emissions of carbon dioxide, nitrous oxide, and chlorofluorocarbons (CFCs) will require substantial reductions in order to stabilize their atmospheric concentrations at sustainable levels.

In 1992, at the Earth Summit in Rio de Janeiro, the United States, along with 142 other nations, signs the United Nations Framework Convention on Climate Change, committing to a voluntary stabilization of greenhouse gas emissions to 1990 levels.

In 1994, The Department of Energy reports nearly 1,400 million metric tons of carbon dioxide was released into the atmosphere in 1993, an increase of about 2.5 percent over 1992 levels. The report attributes the increase to

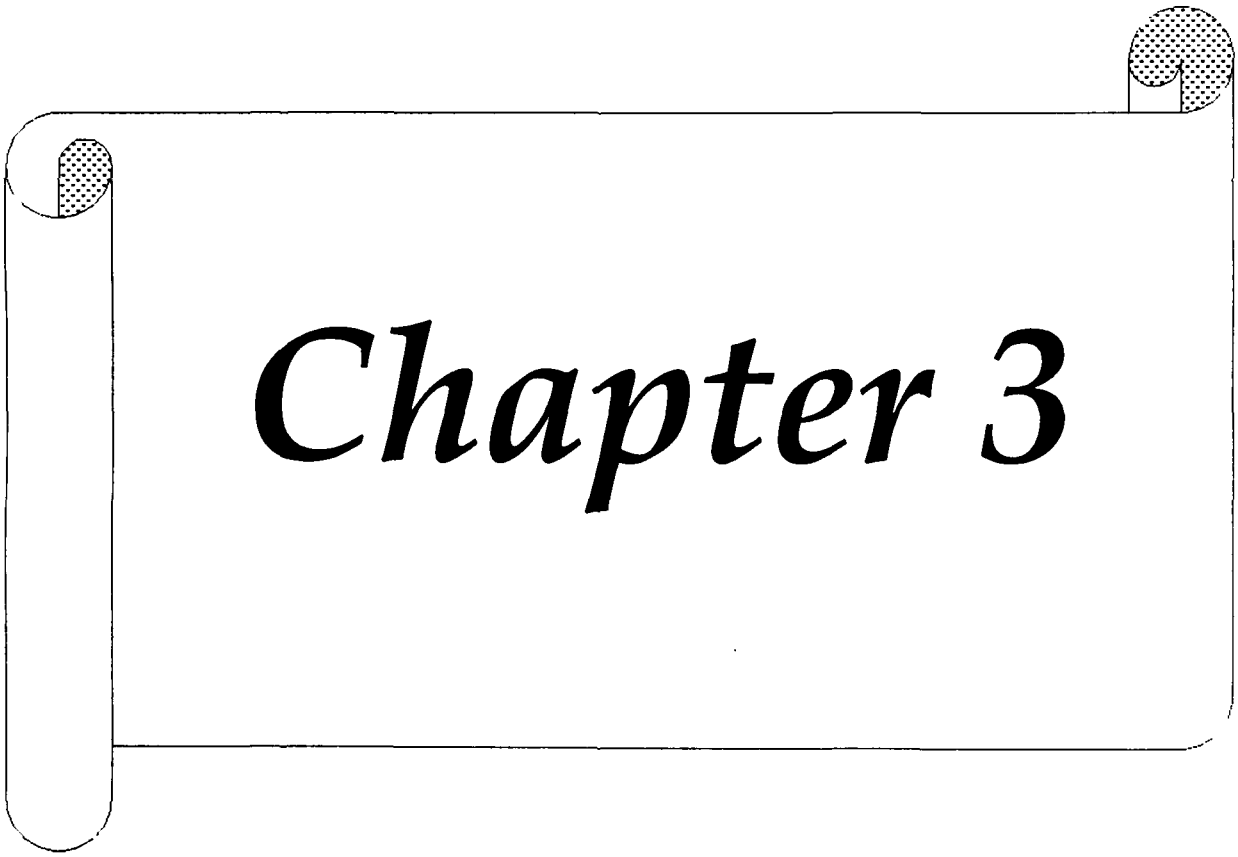
industry, transportation, agriculture, electricity production and a higher use of coal and natural gas.

In 1995, The IPCC issues its Second Assessment Report, stating for the first time "the balance of evidence suggests that there is a discernable human influence on the global climate."

In 1997, The Kyoto Protocol to the United Nations Framework Convention on Climate Change is created in Kyoto, Japan. The document calls for binding global warming pollution reductions worldwide.

In 2000, The IPCC releases its Third assessment Report that more thoroughly explains humans' involvement in the disruption of the earth's climate and warns that global average temperature increases will be greater than earlier estimates. Governments fail to reach agreement on the rules to implement the Kyoto Protocol at The Hague in November.

In 2001, with new resolve, governments complete the final rules to the Kyoto Protocol despite a decision by the Bush Administration to abandon the treaty. The completion of the treaty rules opened the door for country's to ratify the agreement as governments aimed to enter the Kyoto Protocol into force.


Chapter 3

OBJECTIVE, SCOPE AND METHODOLOGY

Though the term **'Bibliometrics'** was introduced only in 1969 to indicate a new discipline which employs quantitative methods for analysis of various aspects of written documents, its origin can be traced to be effort of early 20th century documentalists to apply mathematical and statistical analysis to bibliographical units. The most prominent effort were that of **Cole and Eales, Hulme, Lotka, Zipf, Bradford, Ranganthan, Price, Kessler, Garfield, by Egghe**.

The discovery of the empirical laws of bibliometrics has led to a series of studies which can be broadly differentiated into quantitative and qualitative. In fact, the early statistical studies of Cole and Eale, Hulme, Lotka, Zipf, and Bradford belong to the quantitative category B.C Brooks is of opinion that there are five such general objectives:

(1) Design of more economic information system and networks.

(2) Improvement of efficiency rates of information handling process.

(3) Identification and measurement of deficiencies in bibliographical services.

(4) Prediction of publishing trends; and

(5) Discovery and elucidation of empirical laws that can provide a basis for developing a theory of information science.

SCOPE

The present study is according to the papers abstracted in Biological Abstracts on the research output on ***'Global Warming'*** over a period of 10 years as cited above However, the findings are likely to have general implications for the scientific community working on ***'Global Warming'*** The period of study is 1992 – 2001

OBJECTIVES

The major purpose of the present study is to examine the studies and research conducted during the last 10 years on the various aspects of the 'Global Warming' and can be summarized as follows

- To ascertain the strength and weakness of the research activities conducted during the last 10 years on ***'Global Warming'***
- To draw a detailed picture of the way in which literature has developed during the period of study and the relative distribution in the various facets of the subject field
- To identify the gaps in the research output in respect of various forms of ***'Global Warming'*** and its allied areas
- To identify in quantitative terms the relative use of the different forms of the documents, authorship pattern, language etc and their chronological scattering
- To understand the core journals for the scientists working on ***'Global Warming'*** and to identify them
- To investigate the degree of collaboration in authorship in the field of ***'Global Warming'***

Methodology

The following methods were adopted for the present study:

Literature Survey

I have consulted various sources for the selection of topic such as Chemical Abstracts, Index Medicus and Biological Abstracts.

Finally I selected ***'Global Warming'*** in Biological Abstracts on the basis of my interest in Botany and the availability of its reference.

SOURCE CARD (Bibliometric Analysis : Level – 1)

The entry had been prepared on a card of 3" x 5" size. The following details had been noted down on the card.

First of all there was first name (surname) of the authors in the capital letters, followed by the forename in circular bracket in small letter, then full stop(.), then the title of the article up to 3 to 4 words and 3 dot (...). After that name of the journal was given with its volume and issue number followed by page numbers and then followed by year. Journal name was underlined. Within bracket the address of the institution is given in the next line. At the end, language and country of the article was given. For example

		CALDEIRA (Ken) and KASTING (James F)
		Insensitivity of global warming ... Nature, 366(6452), p251-253, 1993. (Global Climate Research Division, Lawrence Livermore National Laboratory, Livermore) English U.S.A.

REFERENCE CARD (Citation Analysis : Level – 2)

In this reference card name of the author(s) was given followed by two or three words of the title then name of the journal and year was given.

MANABE (Syukoro) Global Warming and ... Science 1993

The above cards were kept with the respective source cards.

Citation Analysis

According to **Garfield** "true citation analysis is one which deals with works cited as having actually been used in the preparation of or having otherwise contributed to the source paper". In the present study, this method is used for measuring the relative use of journal as sources of research information and also for identifying the core literature in specialized area or discipline. The journals present in Aligarh were studied and the references

were taken out from the articles. Although this is not what is required normally this method was used because of the constraint of time and because it gives a fairly accurate picture of the actual data.

Analysis

The total data based on the entries has been collected and analysed under the following headings;

I. Yearwise analysis of the paper.

II. Ranking of authors

III. Authorship pattern

IV. Ranking of journals

V. Geographical analysis (country wise)

VI. Language wise distribution of paper

I. Year Wise Analysis of the Papers:-

The chronological study will tell about the number of articles published in a year. The graph will show the upward and downward trend in the publication. The chronological study helps in the services of the library.

II. Ranking of Authors:-

This is done to know the eminent personalities in the subject. The data cards of different contributors in the field were separated out. Authors are arranged in the order of their decreasing productivity.

III. Authorship Pattern:-

This shows that Authorship pattern whether the single authorship is more popular or the team research.

IV. Ranking of Journals:-

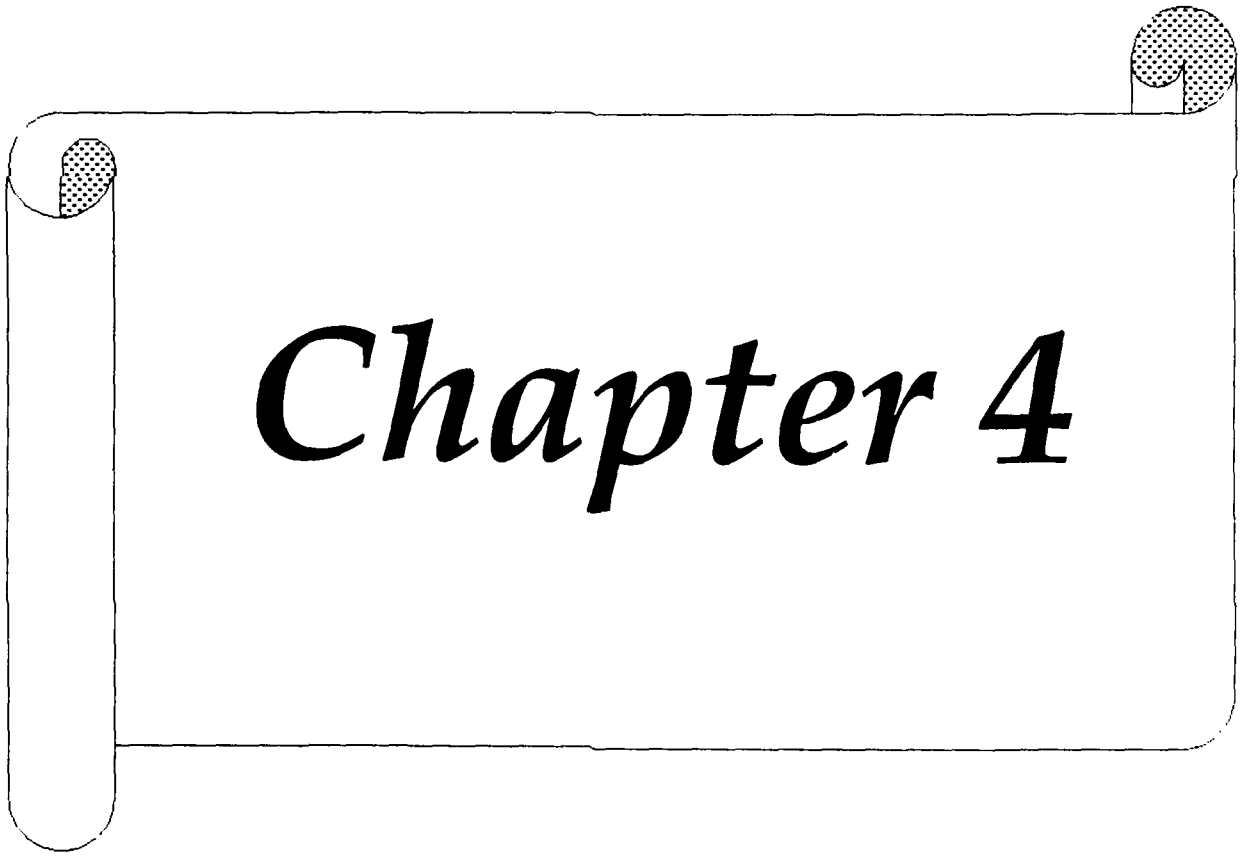
The main objective of this study is to identify the core journal containing the research literature on Global Warming. To conduct this, the items published in different periodicals, are grouped together and counted. It is necessary to know the most productive periodicals in the subject. The information is useful for libraries as well as to the research scholars.

V. Geographical Analysis (i.e. Country wise):

This is done to find out the geographical scattering of items while studying the use pattern of research literature in the subject under study.

VI. Language wise distribution of papers:-

As the Biological Abstracts is the most comprehensive source on its subject, its scope is international. In other words, Biological Abstract reports items published from different countries in languages. It is, therefore, important to know the most dominant language.


Chapter 4

DATA ANALYSIS, INTERPRETATION AND REPRESENTATION

Bibliometric analysis is used to find out the nature and characteristics of ***'Global Warming'***, research is based on the papers published for a period of 10 years (1992 -2001).

The analysis is done in two steps. Firstly, the published papers were analysed, Secondly, the citation appended to the papers in the former were analysed.

Analysis of the papers

In the first level of analysis, the following was done:-

- Year wise analysis of papers.
- Ranking of Authors.
- Authorship pattern.
- Ranking of Journals.
- Geographical analysis.
- Language wise distribution of papers.

LEVEL – 1

BIBLIOMETRIC ANALYSIS

Year wise analysis of the papers

The table -1 showed that the maximum number of papers were published in the year 1995 i.e. 130 papers and the minimum appeared in year 1992 i.e. 49 papers, during a period of 10 years (1992 – 2001).

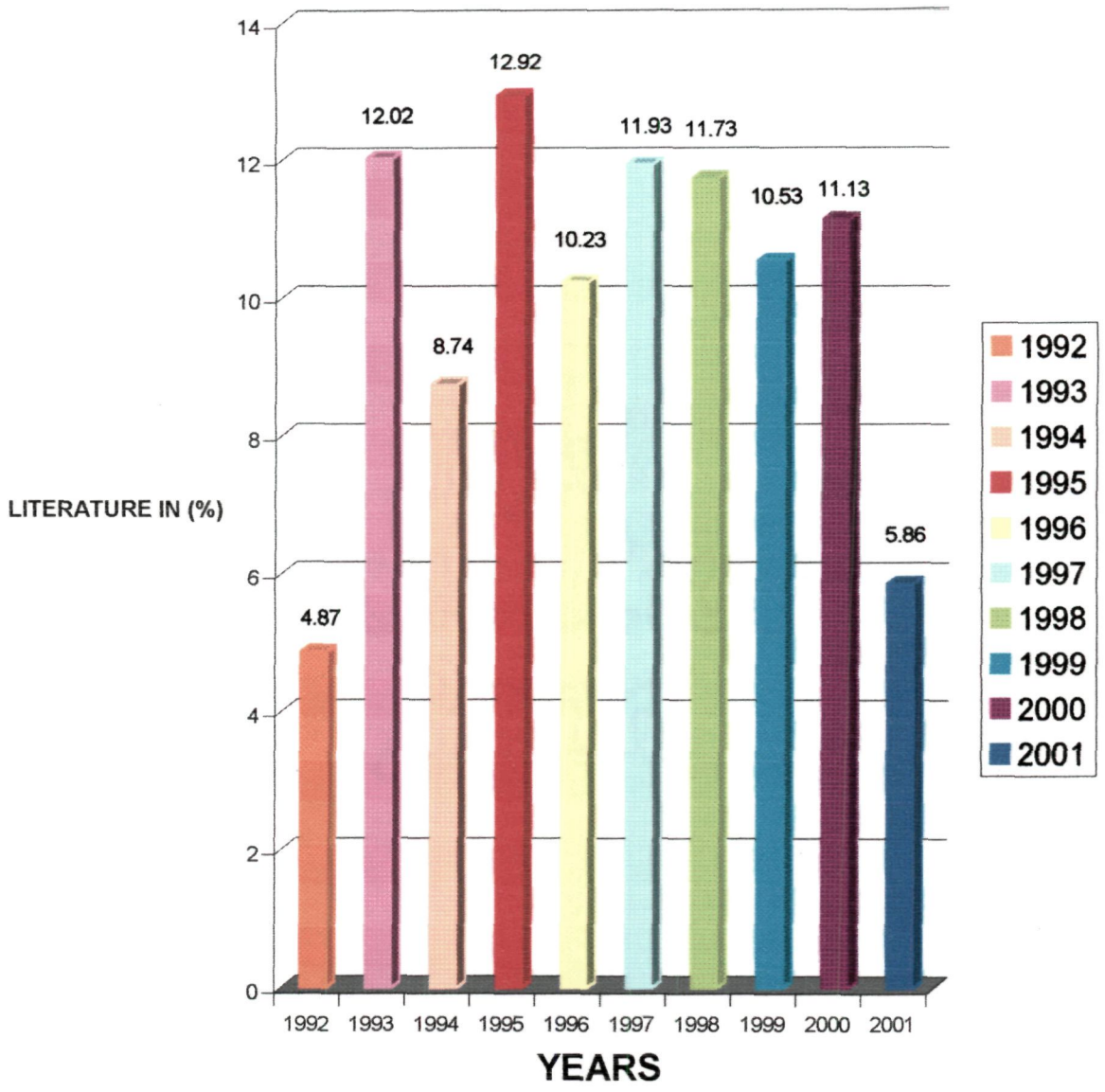
Table – 1

Chronological Distribution

Years	No. of papers	% age	Cumulative % age
1992	49	4.87	4.87
1993	121	12.02	16.89
1994	88	8.74	25.63
1995	130	12.92	38.55
1996	103	10.23	48.78
1997	120	11.93	60.71
1998	118	11.73	72.44
1999	106	10.53	82.7
2000	112	11.13	94.1
2001	59	5.86	99.96
Total	**1006**		

Year wise analysis of papers show that research work on ***'Global Warming'*** increased from 1993 and was at its peak in 1995 and maintained its peak later also. The year 2001 show less output because there is chance of papers that may be covered in later years.

YEAR- WISE DISTRIBUTION



Ranking of authors

The table-2 showed the ranking in the 10 years study of '***Global Warming'*** out of the 1831 authors, 961 have written 1 article, 105 have written 2 articles, 43 have written 3 articles and 28 have written 4 articles each, and so on .

Among the authors **F. Ian Woodward** is the most productive author with 21 articles, **Syukoro Manabe** is on the second position with18 articles whereas, **Jorge L. Sarmiento** is on the third position with 14 articles. Due to joint authorship the number of authors has increased.

Table –2

Ranking of authors

S. No.	Rank	Author's Name	92	93	94	95	96	97	98	99	00	01	Sum
1	1	Woodward (F.Ian)	-	1	2	6	1	4	4	2	1	-	21
2	2	Manabe (Syukoro)	-	3	2	2	-	5	4	1	1	-	18
3	3	Sarmiento (Jorge L)	1	2	1	3	-	-	4	2	-	1	14
4	4	Jacoby (H)	-	1	4	2	-	3	-	2	1	-	13
5	4	Jones (P.D.)	1	-	2	4	3	-	-	1	2	-	13
6	5	Houghton (J.T.)	-	3	-	4	2	1	-	2	-	-	12
7	6	Beerling (DJ)	3	2	1	-	-	1	1	-	2	1	11
8	6	ChapinIII (F.Start)	2	3	-	1	-	1	2	-	1	1	11
9	7	Balling (Robert C)	1	2	1	-	1	3	-	-	2	-	10
10	8	Easterling (William E)	-	-	1	2	2	-	2	1	1	-	9
11	8	Prinn (R.G.)	-	-	2	-	3	3	-	-	1	-	9
12	8	Wang (C)	2	3	-	-	1	2	-	-	1	-	9
13	9	Hogg (I.D.)	1	2	-	-	2	2	-	1	-	-	8
14	9	Impens (I)	1	-	1	1	-	1	1	1	2	-	8
15	9	Swart (Robert J)	-	2	-	2	-	2	-	1	1	-	8
16	9	Wood (Chris M)	1	3	-	1	1	-	2	-	-	-	8
17	9	Cox (Peter M)	1	-	1	-	2	2	-	1	-	1	8
18	9	Cairns (Michael A)	-	-	1	1	1	1	-	1	2	1	8
19	10	Davis (A.J.)	2	2	-	-	1	-	1	-	1	-	7
20	10	Fearnside (Philip M)	1	-	1	1	-	-	2	1	1	-	7
21	10	Idso (S.B.)	-	1	1	-	2	1	-	1	1	-	7
22	10	Kobak (K.I.)	-	-	2	1	-	1	1	-	-	2	7

23	10	Hulme (M)	1	-	1	2	2	-	-	-	-	1	7
24	10	Kasting (James F)	-	1	-	1	1	1	1	1	1	-	7
25	10	Melillo (Jerry M)	-	-	1	1	1	2	2	-	-	-	7
26	10	Rosenberg (Norman)	-	1	1	-	-	1	1	2	1	-	7
27	10	Kroeze (Carolin)	-	1	-	-	-	2	1	-	-	1	6
28	11	Lacis (Andrew)	2	-	1	-	-	1	1	1	-	-	6
29	11	Ledig (F. Thomes)	-	2	-	1	-	1	-	-	-	2	6
30	11	Bergeron (Y)	2	-	1	-	1	-	-	2	-	-	6
31	11	Belts (R.A.)	-	1	2	-	-	1	1	-	-	1	6
32	11	Caldiera (Ken)	-	-	1	1	2	-	2	-	-	-	6
33	11	D'arrigo (R)	1	-	-	2	-	1	-	-	-	2	6
34	11	Campbell (C.La)	-	1	1	1	2	1	-	-	-	-	6
35	11	Goldberg (Richard)	2	-	-	1	1	-	-	-	1	1	6
36	11	Harte (John)	-	1	1	-	-	-	1	1	2	-	6
37	12	Harnisch (J)	-	1	-	-	1	1	1	-	1	-	5
38	12	Karelin (D.V.)	1	-	1	1	1	-	-	1	-	-	5
39	12	Laurance (William F)	-	2	-	-	-	1	1	1	-	-	5
40	12	Mitchell (John F.B)	2	-	-	1	1	-	1	-	-	-	5
41	12	Neilson (Ronald P)	-	1	1	-	-	1	-	-	-	2	5
42	12	Wigley (Tom M.L)	-	3	-	1	1	-	-	-	-	-	5
43	12	Box (Elgene O)	1	-	1	-	-	1	2	-	-	-	5
44	12	Aber (John D)	-	1	-	2	1	-	-	-	1	-	5
45	12	Velichko A.A)	2	-	1	-	-	1	1	-	-	-	5
46	12	Reid (J)	-	1	-	1	-	-	3	-	-	-	5
47	12	Willables (Donald)	1	-	-	2	1	1	-	-	-	-	5
48	12	Akinoto (Hajime)	-	1	1	-	-	-	1	1	-	1	5
49	12	Berthold (Peter)	-	2	-	1	1	1	-	-	-	-	5
50	12	Davidson (E)	-	-	1	1	1	1	-	1	-	-	5

51	12	Crutzen (Paul J)	1	-	-	3	-	-	-	-	-	1	5
52	12	Hogan (M.E)	-	1	-	-	1	1	1	-	-	-	5
53	12	Lowton (John H)	-	2	1	-	-	-	-	1	1	1	5
54	12	Tett (S.F.B)	-	-	-	-	1	1	3	-	-	-	5
55	12	Magnuson (John J)	-	-	1	1	-	2	-	1	-	-	5
56	12	Brigham (Scott D)	1	-	2	-	-	-	-	-	-	2	5
57	12	Diaz (M.F)	-	-	-	-	1	1	1	2	-	-	5

28 Authors contributed 4 articles each.

43 Authors contributed 3 articles each.

105 Authors contributed 2 articles each.

961 Authors contributed 1 articles each.

Authorship Pattern

Multiple authorship is a characteristics feature of modern science and there has been a consistent trend towards increased collaboration in all the branches of the sciences.

It has been found that the rate of increase in the multiple authorship varies considerably with the subject concerned.

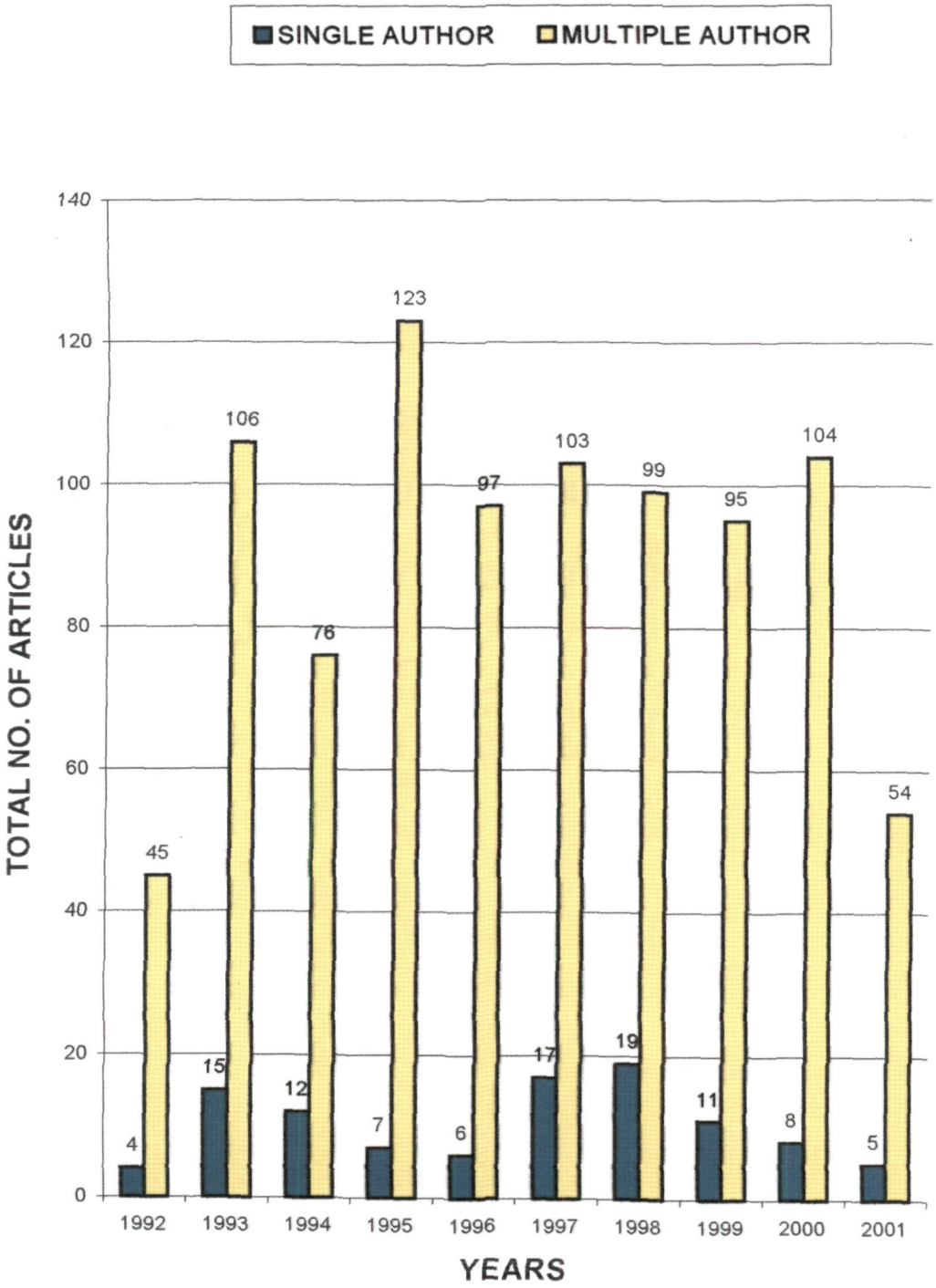
Table -3 shows the pattern of single & multiple authorship.

Table – 3
Authorship distribution pattern

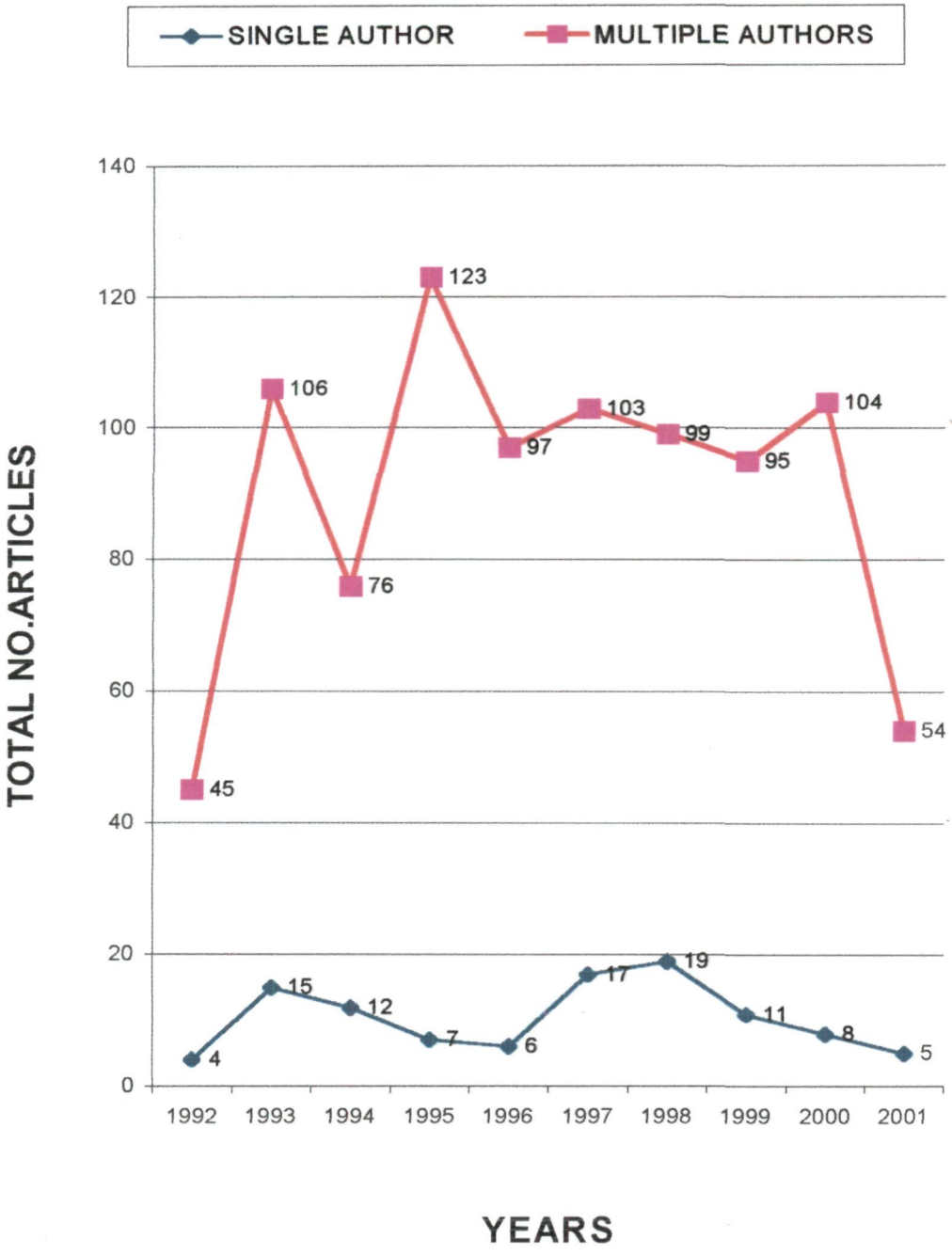
S. No.	Year	Single Authorship	% age	Multiple Authorship	% age
1	1992	4	3.84	45	4.98
2	1993	15	14.42	106	11.75
3	1994	12	11.53	76	8.42
4	1995	7	6.73	123	13.63
5	1996	6	5.76	97	10.75
6	1997	17	16.34	103	11.41
7	1998	19	18.26	99	10.97
8	1999	11	10.57	95	10.53
9	2000	8	7.69	104	11.52
10	2001	5	4.8	54	5.98
Total		**104**		**902**	

Grant Total = 104 + 902 = 1006

AUTHOR-WISE DISTRIBUTION



AUTHOR-WISE DISTRIBUTION



Ranking of Journals

251 journals were analysed in relation to their productivity. The more frequently published journals, consulted by the scientistsworking on ***'Global Warming'*** were identified and the ranked lists of journals as prepared by decreasing productivity.

The list of journals shows that the **'Climatic Change'** is the journal with the most articles. It has 72 out of 1006 articles i.e.7.15% of the total. Next three positions are occupied by journals like **'Nature'** (5.06%), **'Science'** (4.17%) and '**Ambio'** (3.87%) respectively. These four journals constitute around 20.25% of the literature, and the remaining 79.75% is covered by 247 journals. The following table – 4 shows ranking of journals.

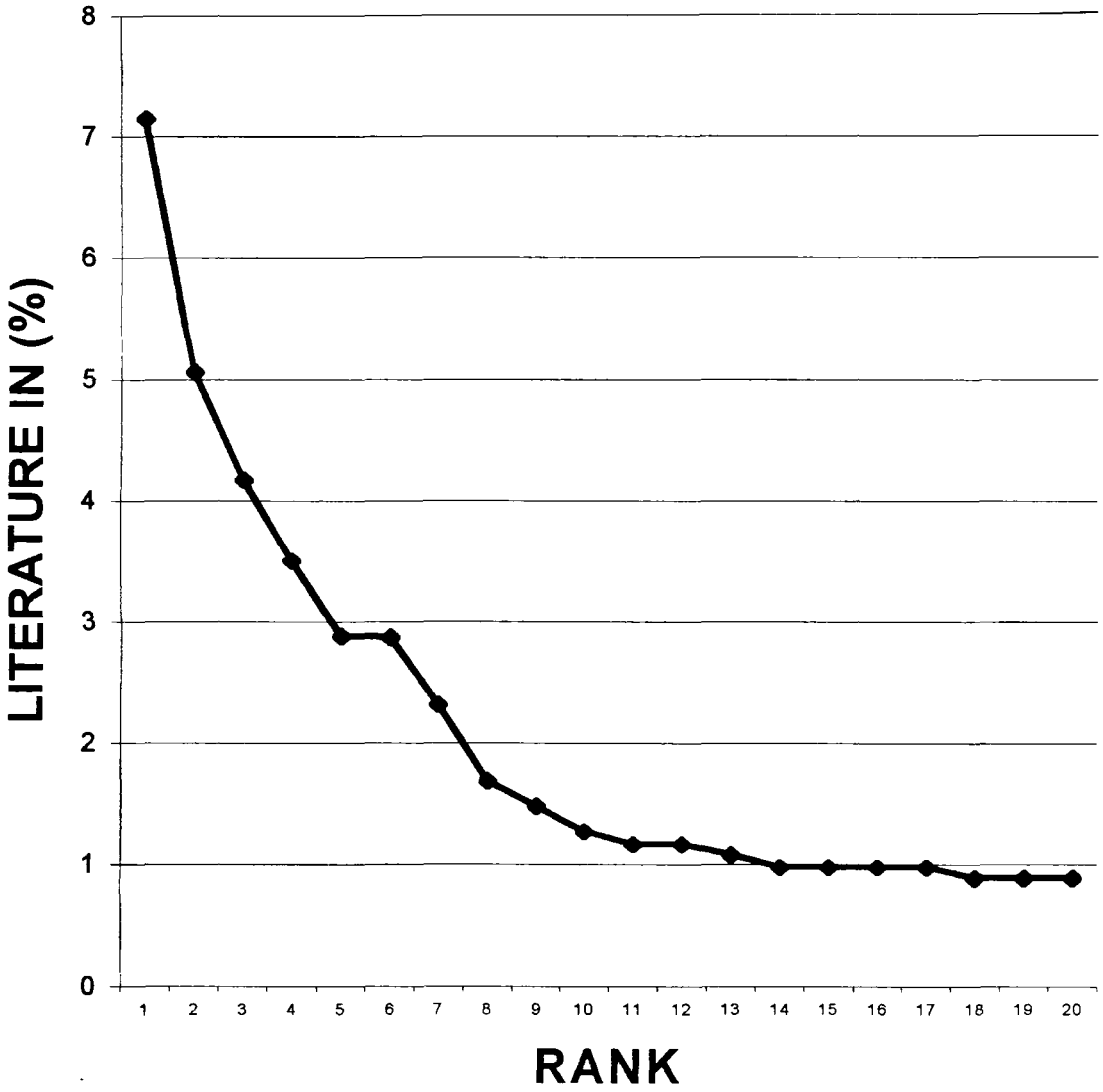
Table – 4

Ranking of journals

S. No.	Rank	Name of Journal	92	93	94	95	96	97	98	99	00	01	T	% age
1	1	Climatic change	3	5	7	8	12	11	6	5	8	7	72	7.15
2	2	Nature	2	5	6	5	3	6	7	8	4	5	51	5.06
3	3	Science	2	4	5	2	4	6	4	7	5	3	42	4.17
4	4	Ambio	3	2	4	2	5	8	6	4	3	2	39	3.87
5	5	Water Air and Soil Pollution	-	5	3	1	6	7	4	3	5	2	36	3.57
6	6	Environmental Monitoring & Assessment	-	1	6	3	1	6	5	4	3	-	29	2.88
7	7	Atmospheric Environment	-	1	-	6	5	5	3	-	1	4	25	2.48
8	8	Science of the Total Environment	2	4	6	2	3	3	-	1	-	-	21	2.08
9	9	Environmental Science & Technology	1	1	3	1	1	2	3	2	2	1	17	1.68
10	10	Tellus Series B Chemical & Physical Meteorology	-	3	1	2	-	2	3	1	1	2	15	1.49
11	11	Climate Research	1	2	1	1	1	3	2	0	1	2	13	1.29
12	12	Environmental Pollution	2	3	2	1	1	-	-	2	-	1	12	1.19
13	12	Ecological Applications	1	2	1	3	3	-	2	-	1	1	12	1.19
14	13	Ecological Modelling	-	1	2	1	1	2	-	1	1	-	11	1.09
15	14	Forest Ecology Management	1	2	1	1	-	3	2	-	-	-	10	0.99
16	14	Environmental Management	1	-	-	2	3	-	1	1	2	-	10	0.99

17	14	Global Biogeochemical Cycle	-	1	2	1	-	2	3	-	1	-	10	0.99
18	14	Paleogeography Paleoclimatology Paleoecology	-	-	-	4	-	2	-	-	4	-	10	0.99
19	15	Journals of Environmental Management	1	1	1	2	-	-	1	2	-	1	9	0.89
20	15	Theoretical & Applied Climatology	-	1	2	1	2	1	-	-	2	-	9	0.89
21	15	Biomass & Bioenergy	-	2	-	1	2	-	1	-	2	1	9	0.89
22	15	Journal of Thermal Biology	2	-	1	-	2	-	1	-	2	1	9	0.89
23	15	Waste Management	-	-	4	3	2	-	-	-	-	-	9	0.89
24	16	**6 Periodicals published 8 articles each.**											48	4.77
25	17	**8 Periodicals published 7 articles each.**											56	5.56
26	18	**10 Periodicals published 6 articles each.**											60	5.56
27	19	**8 Periodicals published 5 articles each.**											40	3.97
28	20	**11 Periodicals ublished 4 articles each.**											44	4.97
29	21	**18 Periodicals published 3 articles each.**											54	5.36
30	22	**55 Periodicals published 2 articles each.**											110	10.9
31	23	**122 Periodicals published 1 article each.**											112	11.1

RANKING OF LITERATURE



Country wise distribution of papers

Table - 5 shows country wise distribution of papers. **U.S.A**. is the most productive country with 298 articles (29.62%), **U.K.** is the second most productive country with 119 articles (11.82%) and **Canada** is the third most productive country with 81 articles (8.05%).

Table – 5

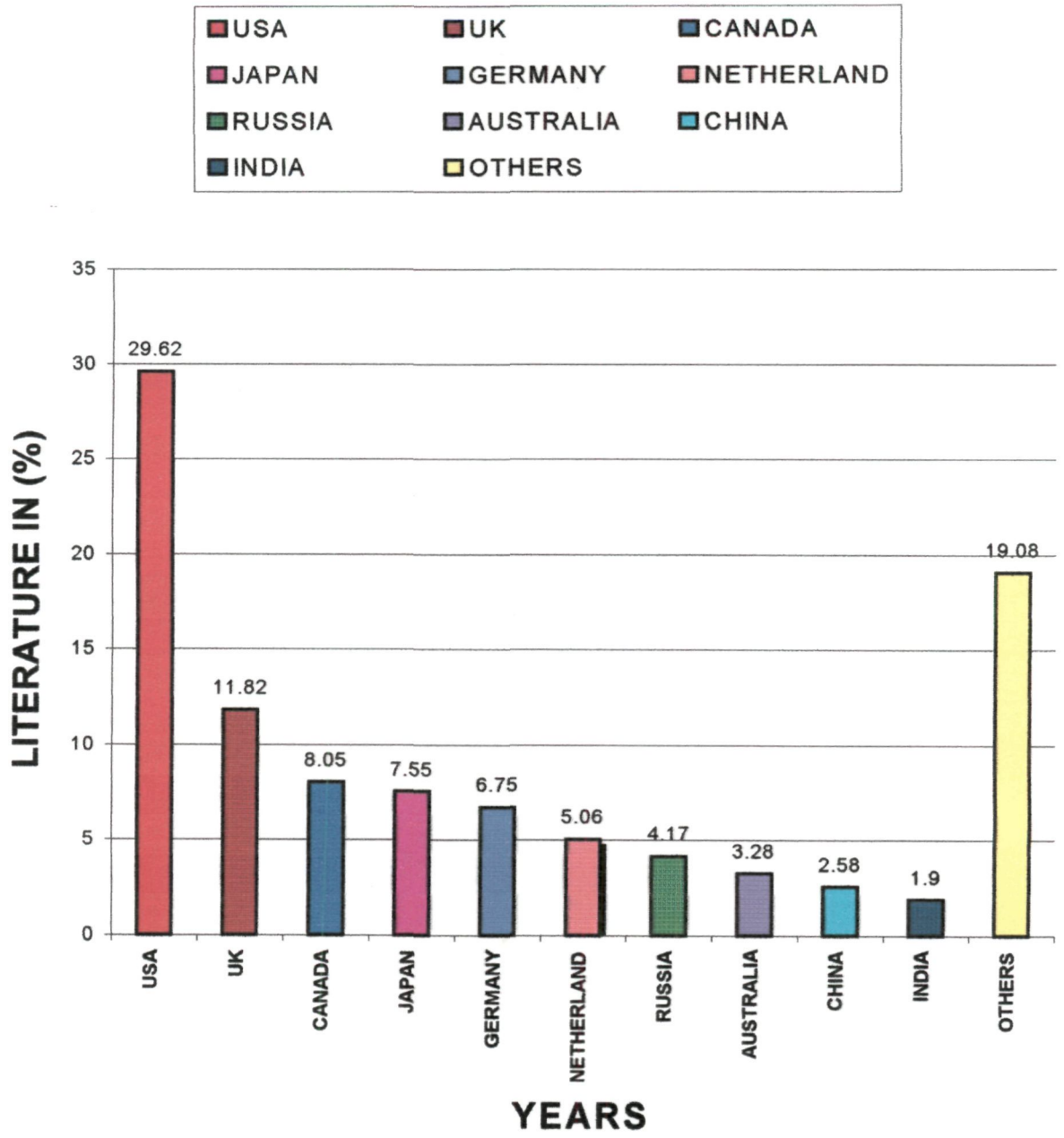
Country wise distribution

S. No.	Rank	Country	92	93	94	95	96	97	98	99	00	01	T	% age
1	1	U.S.A.	18	33	25	31	17	33	26	44	52	19	298	29.62
2	2	U.K.	8	11	5	18	8	12	16	13	21	7	119	11.82
3	3	Canada	3	15	10	7	20	11	15	-	-	-	81	8.05
4	4	Japan	2	15	10	25	5	7	3	4	-	5	76	7.55
5	5	Germany	1	10	5	9	5	8	15	7	5	3	68	6.46
6	6	Netherlands	1	6	5	5	10	9	5	6	2	4	53	5.16
7	7	Russia	2	5	5	2	5	5	3	4	5	6	42	4.17
8	8	Australia	1	2	4	1	5	5	4	5	4	2	33	3.28
9	9	China	3	3	-	1	4	5	5	1	1	3	26	2.28
10	10	India	5	1	4	2	1	1	3	-	3	-	20	1.98
11	11	Sweden	1	1	1	2	3	3	2	3	1	2	19	1.59
12	12	France	1	1	2	-	4	-	4	1	2	-	15	1.49
13	13	Brazil	1	3	-	1	1	2	-	3	2	1	14	1.39
14	14	Finland	-	1	1	1	3	2	-	4	1	-	13	1.29
15	15	Norway	-	2	-	2	-	3	1	1	2	-	11	1.09
16	16	Spain	-	-	-	4	-	-	2	-	3	-	9	0.89
17	16	Switzerland	-	3	1	2	-	1	1	-	-	1	9	0.89
18	17	New Zealand	-	-	-	-	2	-	1	-	5	-	8	0.79

19	18	Israel	-	2	-	2		1	1	1	-	-	7	0.69
20	18	Italy	-	-	-	4	-	-	1	-	1	-	7	0.69
21	18	South Africa	1	1	-	-	3	-	-	2	-	-	7	0.69
22	19	Denmark	-	-	2	-	-	1	1	-	2	-	6	0.59
23	20	Belgium	-	1	-	1	-	2	-	1	-	-	5	0.49
24	20	Poland	-	2	1	-	-	-	-	-	-	2	5	0.49
25	21	Austria	-	-	-	-	-	2	-	1	1	-	4	0.39
26	21	Argentina	-	-	-	3	-	-	1	-	-	-	4	0.39
27	21	Taiwan	-	-	2	-	1	-	-	1	-	-	4	0.39
28	22	Egypt	-	-	-	1	-	2	-	-	1	-	4	0.39
29	22	Greece	-	-	1	-	-	1	-	-	1	-	3	0.29
30	22	Mexico	-	1	1	1	-	-	-	-	-	-	3	0.29
31	22	Philippines	-	-	-	-	-	1	1	1	-	-	3	0.29
32	22	Portugal	-	-	-	-	1	-	1	-	-	1	3	0.29
33	23	Ghana	-	-	-	1	-	-	-	1	-	-	2	0.19
34	23	Indonesia	-	-	-	-	-	1	-	-	1	-	2	0.19
35	23	Lebanon	-	-	1	-	-	-	1	-	-	-	2	0.19
36	23	Panama	-	-	-	1	-	-	-	-	1	-	2	0.19
37	23	Chile	-	-	-	-	-	1	-	-	1	-	2	0.19
38	23	Costa Rica	-	-	-	-	1	-	1	-	-	-	2	0.19
39	23	Cuba	-	-	-	-	-	1	-	-	-	1	2	0.19
40	23	Czech Republic	-	-	-	1	-	-	1	-	-	-	2	0.19
41	23	Peru	-	-	-	-	1	-	-	1	-	-	2	0.19
42	23	Ecuador	-	-	-	1	-	-	1	-	-	-	2	0.19
43	24	Estonia	-	-	1	-	-	-	-	-	-	1	2	0.19
44	24	Ethiopia	1	-	-	-	-	-	-	-	-	-	1	0.09
45	24	Gambia	-	1	-	-	-	-	-	-	-	-	1	0.09
46	24	Hong Kong	-	-	1	-	-	-	-	-	-	-	1	0.09

47	24	Hungry	-	-	-	-	1	-	-	-	-	-	1	0.09
48	24	Iceland	-	-	-	-	-	-	-	1	-	-	1	0.09
49	24	Kazakstan	-	-	-	-	-	-	1	-	-	-	1	0.09
50	24	Kenya	-	-	-	-	-	-	-	-	1	-	1	0.09
51	24	Kuwait	-	-	-	-	-	-	-	-	-	1	1	0.09
52	24	Scotland	-	-	-	-	1	-	-	-	-	-	1	0.09
53	24	Slovakia	-	-	-	-	-	-	-	1	-	-	1	0.09
54	24	Tanzania	-	1	-	-	-	-	-	-	-	-	1	0.09
55	24	Turkey	-	-	-	1	-	-	-	-	-	-	1	0.09
56	24	Venezuela	-	-	-	-	-	-	-	1	-	-	1	0.09
57	24	Yugoslavia	-	-	-	-	-	1	-	-	-	-	1	0.09

COUNTRY-WISE DISTRIBUTION



Language wise distribution of papers

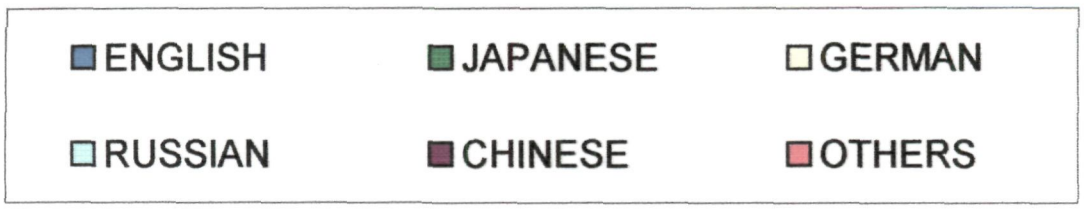
Table -6 shows language wise distribution of papers. **English** is the most prominent language in the publication of ***'Global Warming'*** research, **Japanese** is on second place and **German** is on the third number.

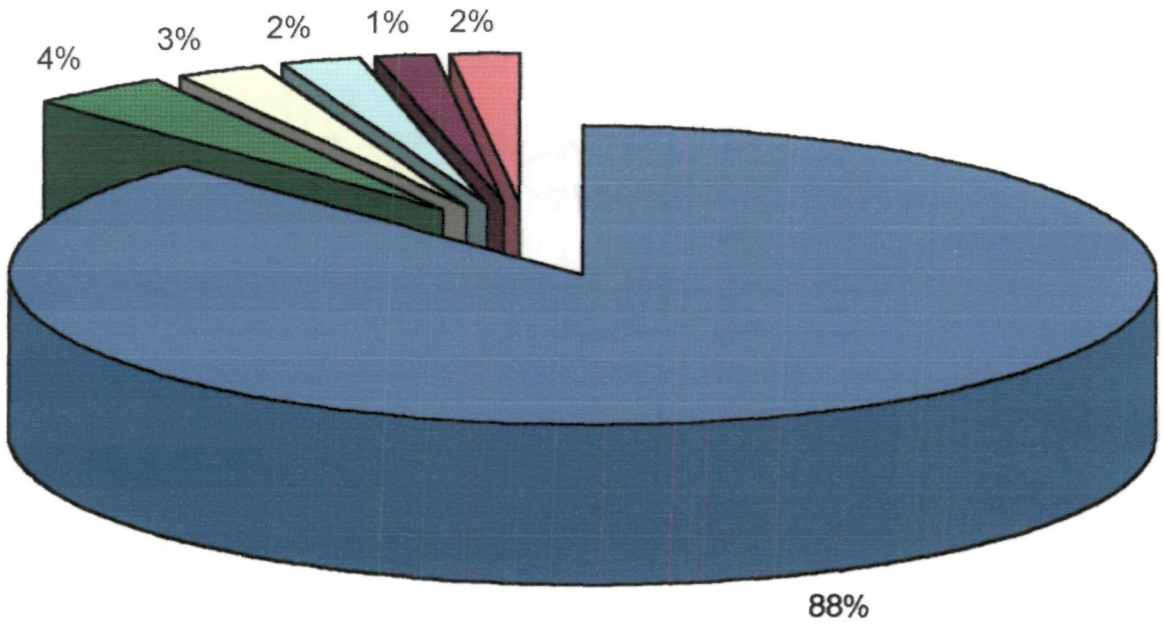
Table-6

Language wise distribution of papers

S. No.	Rank	Language	Total	% age
1	1	English	883	87.77
2	2	Japanese	39	3.87
3	3	German	26	2.58
4	4	Russian	23	2.28
5	5	Chinese	15	1.49
6	6	French	11	1.09
7	7	Spanish	3	0.29
8	7	Italian	3	0.29
9	8	Greek	2	0.19
10	9	Portuguese	1	0.19
		Grant Total	**1006**	

LANGUAGE-WISE DISTRIBUTION





LEVEL – 2

CITATION ANALYSIS

To carry out citation analysis, only journals available in Aligarh libraries were taken up.

The numbers of such journal are 2 (i e **'Nature'** and **'Science'** and source articles are 93, which gave us a total of 689 references After this analysis has been done about

- Ranked list of cited authors, and
- Ranked list of cited journals

Table – 7

Chronological Analysis

S. No.	Year	No. of Citation	% age	Cumulative % age
1	1929	1	0.14	0.14
2	1937	1	0 14	0.28
3	1947	1	0 14	0.42
4	1954	1	0 14	0 56
5	1959	1	0 14	0.7
6	1960	1	0 14	0.84
7	1968 – 1971	15	2 17	2 31
8	1972 – 1977	43	6 24	8 55
9	1978 – 1983	69	10 01	18 56
10	1984 – 1989	113	16 4	34 96
11	1990 – 1995	253	36 71	71 67
12	1996 – 2001	190	27.57	99.24
	Total	**689**		

Half -Life Period

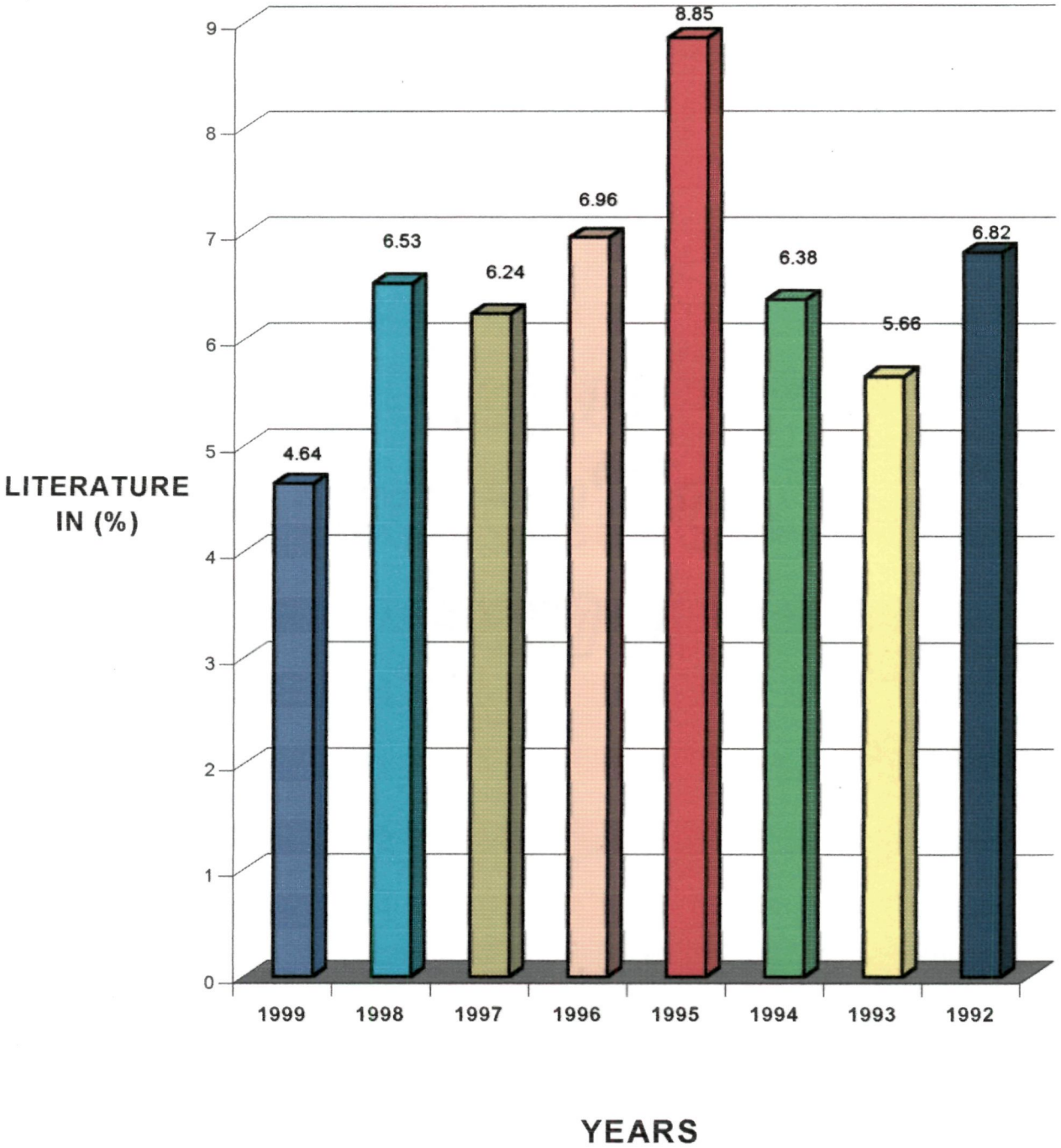
Half - life is a measure of the growth of a discipline. In other words, it also indicates the rate of obsolescence of a discipline. Table-8 shows that 52.09% cited literature come from 8 years out of 41 years i.e. only 8 years provide approximately 50% of the literature which is cited.

Table – 8

Half Life of Literature

S. No.	Year	No. of Citation	% age	Cumulative % age
1	1999	32	4.64	4.64
2	1998	45	6.53	11.17
3	1997	43	6.24	17.41
4	1996	48	6.96	24.37
5	1995	61	8.85	33.22
6	1994	44	6.38	39.6
7	1993	39	5.66	45.27
8	1992	47	6.82	52.09
	Total	**359**		
Total Citations (1929-2001)		**689**		

HALF-LIFE DISTRIBUTION



Ranked List of cited authors

A ranked list of cited authors has been prepared It shows that which author is most frequently cited in the research on ***'Global Warming'*** for the period 1992 -2001

Table- 9 shows that **Syukoro Manabe** is the cited author followed by **J.T. Houghton** and **P.D. Jones** the 2nd and 3rd rank respectively

312 authors have been cited once, 53 authors have been cited twice and 26 authors have been cited thrice

In table -9 numbers in the brackets after years shows how many times that year it cited in level -2 study, for example 1995 -(3) means that author is cited thrice in 1995

TABLE – 9

RANKED LIST OF CITED AUTHORS

S. No.	Rank	Author's Name	Cited Year	Total
1	1	Manabe (Syukoro)	1990 - (2) 1993 - (6), 1994 - 4), 1997 - (9),1998-(4)	25
2	2	Houghton (J T)	1990-(4), 1992-(3) 1994-(2) 1995-(8), 1996-(2) 1997	20
3	3	Jones (P D)	1980,1987,1990-(4),1994(3), 1995, 1998-(5),1999-(2)	17
4	4	Stouffer(R T)	1991-(2),1993-(3),1994-(2) , 1997-(3),1998-(2),1999	13
5	5	Woodward (F Ian)	1987-(3), 1994-(3) 1995 1996, 1997-(2),1998	11
6	5	Mitchall (J F B)	1987,1990-(2),1991,1993-(2), 1995-(4),1999	11
7	6	Sarmiento(J C)	1984,1991,1993,1995,1996-(3), 1998-(2)	9
8	7	Schimel(D)	1991,1994,1995-(5)	7
9	7	Schlesinger(M E)	1987,1991,1992-(2),1993,	7

			1999;2000	
10	7	Mann(M.E.)	1996;1998-(4);1992-(2)	7
11	8	Briffa (K.R.)	1994-(2);1998-(4);	6
12	8	D'arrigo (R)	1987;1989;1995-(2);1996;1998;	6
13	8	Schneider(s.h.)	1974;1994;1996-(2);1999-(2)	6
14	9	Bryan (K)	1969;1990;1991-(3)	5
15	9	Bradley (R.S.)	1993;1995;1998-(2);1999	5
16	9	Broecker (W.S.)	1983;1992;1994;1999-(2)	5
17	9	Gregory (J.M.)	1995-(4);1999	5
18	9	Rodhe (H.)	1991-(2);1992;1993-(2)	5
19	9	Tett (S.F.B.)	1994;1995-(4)	5
20	9	Wigley (T.M.C.)	1990;1992;1995;1996-(2)	5
21	10	Crowley (T.J.)	1999;2000-(2);2001	4
22	10	Diaz (H.F.)	1994;1996-(2);1997	4
23	10	Emanuel (W.R.)	1981;1983;1985;1995	4
24	10	Graham (N.E.)	1991;1995;1996-(2)	4
25	10	Hughes (M.K.)	1994;1998(2);1999	4
26	10	Joos (F)	1992;1996-(2);1998	4
27	10	Henderson-Sellars(A)	1994;1998-(2);1999	4
28	10	Reilly (J)	1993-(3);1999	4

Ranked list of cited journals

Table -10 shows ranked list of cited journals it gives most frequently used journal by '***Global Warming***' research scientists. The list of journals shows that **'Nature'** is the most highly cited journal followed by **'Climatic Change'** and **'Science'** respectively. In this table numbers in brackets after year shows how many times in that year it is cited in level - 2 study e. g. 1995 - (3) means that journal is cited thrice in 1995.

TABLE – 10

RANKED LIST OF CITED JOURNALS

S. No.	Rank	Journal's Name	Cited Year	Total
1	1	Nature	1967;1970;1975;1977;1980; 1983-(2);1984;1987-(2);1990-(4);1991-(4);1992-(3);1993-(6);1994-(8); 1995-(8);1996-(12);1997-(8);1998-(13);1999-(4);2000-(8)	88
2	2	Climatic Change	1977-(3);1985;1989-(4);1990-(10); 1992-(8);1994-(7);1995-(18);1996-(3);1997-(2);1998	57
3	3	Science	1974;1982;1983-(2);1984;1986-(2);1989-(3);1991;1992-(2); 1993; 1994-(2);1995-(6);1996-(6);1997-(6);1998-(5);1999-(8);2000(6); 2001-(3)	56
4	4	Journal of Geophysical Research	1980;1983-(2);1985;1986; 1987; 1988-(3);1990;1991-(2);1992-(3); 1994-(4);1998;1999-(2)	22

5	5	Journal of Climatology	1985;1991-(5);1992-(2);1993-(2); 1994 - (5); 1995 - (3); 1996; 1998	20
6	6	Geophysical Research Letters	1993;1994;1995;1996;1997 (3); 1998; 1999 (7); 2001	16
7	7	Climate Dynamics	1987; 1993; 1994; 1996 (2); 1997; 1998; 1999; 2000	9
8	8	Energy	1992 (4); 1993 (3); 1997	8
9	8	Evolution	1979; 1983; 1986 ; 1987 (2); 1992; 1998; 1999	8
10	9	Global Biogeochemical cycles	1990; 1992; 1995(3); 1996	6
11	9	Holocene	1993 (2); 1998-(3); 2000	6
12	10	Coral reefs	1990; 1997-(2); 1998; 2000	5
13	11	Ecology	1988; 1992; 1996; 1997	4
14	11	Oceologia	1986; 1988; 1989; 1995	4
15	11	Palaeogeography Palaeoclimatology Palaeoecology	1988; 1995-(2); 2000	4
16	11	Ecological applications	1974; 1983; 1993; 1995	4
17	11	Tellus Series B Chemical & Physical Meteorology	1991; 1992-(2); 1998	4

APPLICATION OF THE BIBLIOMETRIC LAWS

Bradford's law

This law state that if scientific journals are arranged according to their decreasing productivity of articles on a given subject they may be divided into a nucleus of periodicals more particularly devoted to the subject and several groups or zones each zone have nearly same number of articles.

The formula is 1:n: n^2 where 1 is the number of periodicals and n is a multiplier.

To check the validity of this law, 251 journals where divided into three zones according to their productivity.

In the first zone 8 journals contained 315 articles; in the second zone 39 journals contained 329 articles and; remaining 204 journals contained 360 in the third zone; according to this the periodicals in each zone covered approximately 1\3 items of the total, for all this data has been taken from table - 4 the analysis shows phenomenon of scattering of items in different zone of periodicals. The first zone is the nucleus zone as it contains 8 periodicals followed by 39 periodicals in second zone and 204 periodicals in third zone the zone thus identified will form an approximately geometric series as given below –

Table – 11

S.No.	Zone	No. of articles	Cumulative No. of articles	No. of journals	Cumulative No. of journals
1	I	315	315	8	8
2	II	329	645	39	47
3	III	360	1006	204	251

8:39:204

Here,

$39 \cong 40 = 8 \times 5$ (Approx.) and $204 \cong 200 = 8 \times 5 \times 5$ (Approx.)

Therefore, now the series is

$8 : 8 \times 5 : 8 \times 5 \times 5$

on substituting,

$5 = n$ we get,

$8 : 8n : 8n^2$

i.e. $1 : n : n^2$

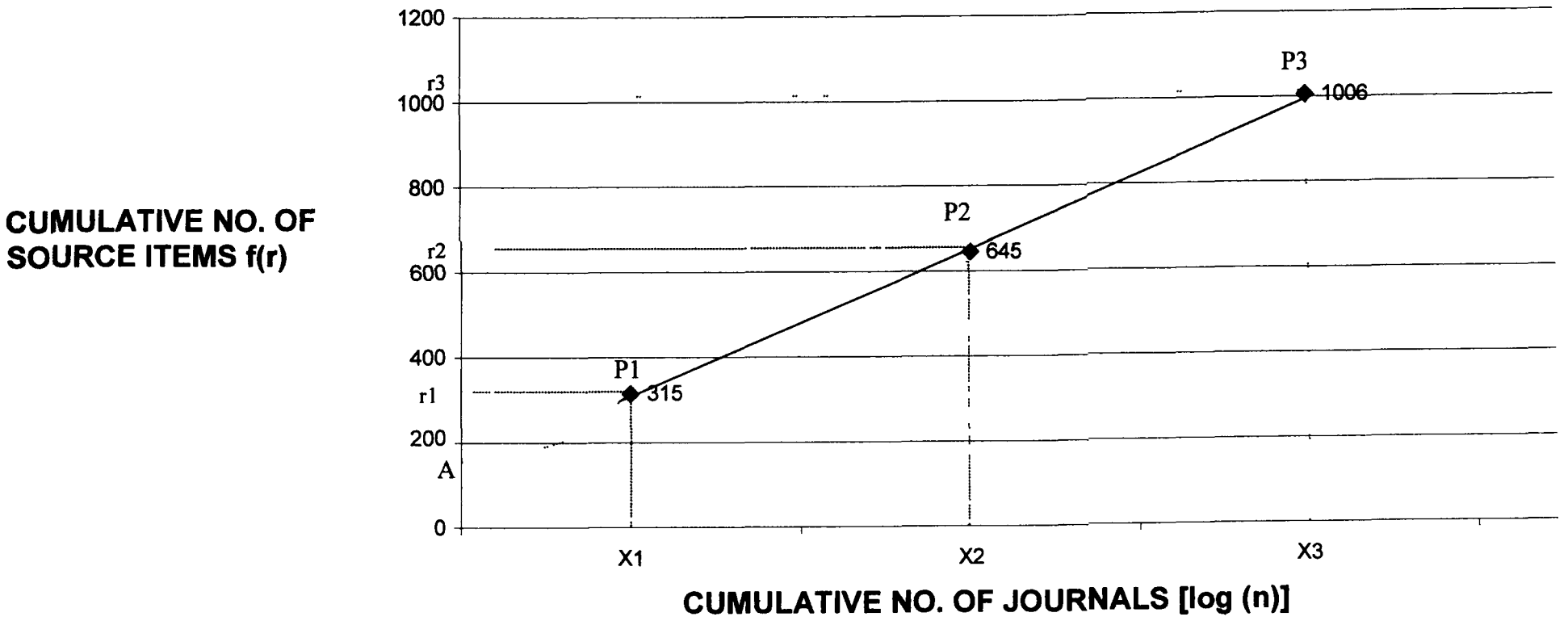
(Where 1 is the number of journals in the nucleus and n is a multiplier)

The number of journals in the nucleus can be obtained by plotting f(r) and log n on semi logarithmic graph paper (a bibliograph), where f(r) is cumulative frequency and log n is log of rank of journals as shown in the graph. This graph is drawn with the help of data analysed and computed in table -11.

The log value of 8 journals in the first zone is 0.9 the log value of 39 journals in the second zone 1.59 and the log value of 204 journals in the third zone is 2.3.

Taking log n on X- axis and number of items, in each zone on X- axis a graph was plotted as shown. The Bibliograph thus obtained is found to be, by and large, similar to Bradford's bibliograph. As the graph begins as a rising curve AP1 and continues as a straight line. The rising part of the graph represents the nucleus of highly productive journals. The points P1, P2 and P3 on the bibliograph are the boundaries of three equiproductive zones in which almost the same number of articles as the nucleus (represented by Or1 = r1 r2 = r2 r3) derived from an increasing larger number journals (represented by oX1, X1X2 and X2X3). **The Bradford's law is proved thus**.

BRADFORD'S BIBLIOGRAPH



Lotka's Inverse Square Law

The Lotka's inverse square law states that the number of scientists who contribute n papers will be $1/n^2$ of those contributing only one paper.

Table –12

No. of Authors	No. of Authors
961	1
105	2
43	3
28	4

Scientist contributing two papers

According to Lotka's inverse square law

No. of scientist publishing n papers = no. of scientist publishing one paper / n^2

Where n = No. of papers

On substituting n = 2 in the above formula

No. of scientist publishing 2 papers = $\frac{961}{2^2}$

$= \frac{961}{4}$

$=240.25$

The number of scientist publishing two papers are 105. However, according to Lotka's Law it should be 240.25 authors which is far more than the actual figure.

Scientist contributing three papers

On substituting, n = 3

No. of scientist publishing 3 papers $= \frac{961}{3^2}$

$= \frac{961}{9}$

$= 106.77$

During the analysis it was found that only 43 authors contributed 3 papers each, which is a less than the calculated figure i.e. 106.77

Scientist contributing four papers

On substituting , n = 4

No. of scientist publishing 4 papers $= \frac{961}{4^2}$

$= \frac{961}{16}$

$= 60.06$

The analysis of the actual data shows that only 28 authors contributed 4 papers figure i.e. 60.06

It may, therefore, be concluded that the trends of research now days have changed as compared to the period when Lotka's law was formulated that is why on the basis of the analysis of the present data it is difficult to testify the validity of Lotka's Law.

Zipf's Law

It is not applied as it deals with the long textual matter of the articles.

Price square Root Law of Scientific Productivity

This law states that " half of the scientific papers are contributed by square root of total number of authors".

Total no. of papers = 1006

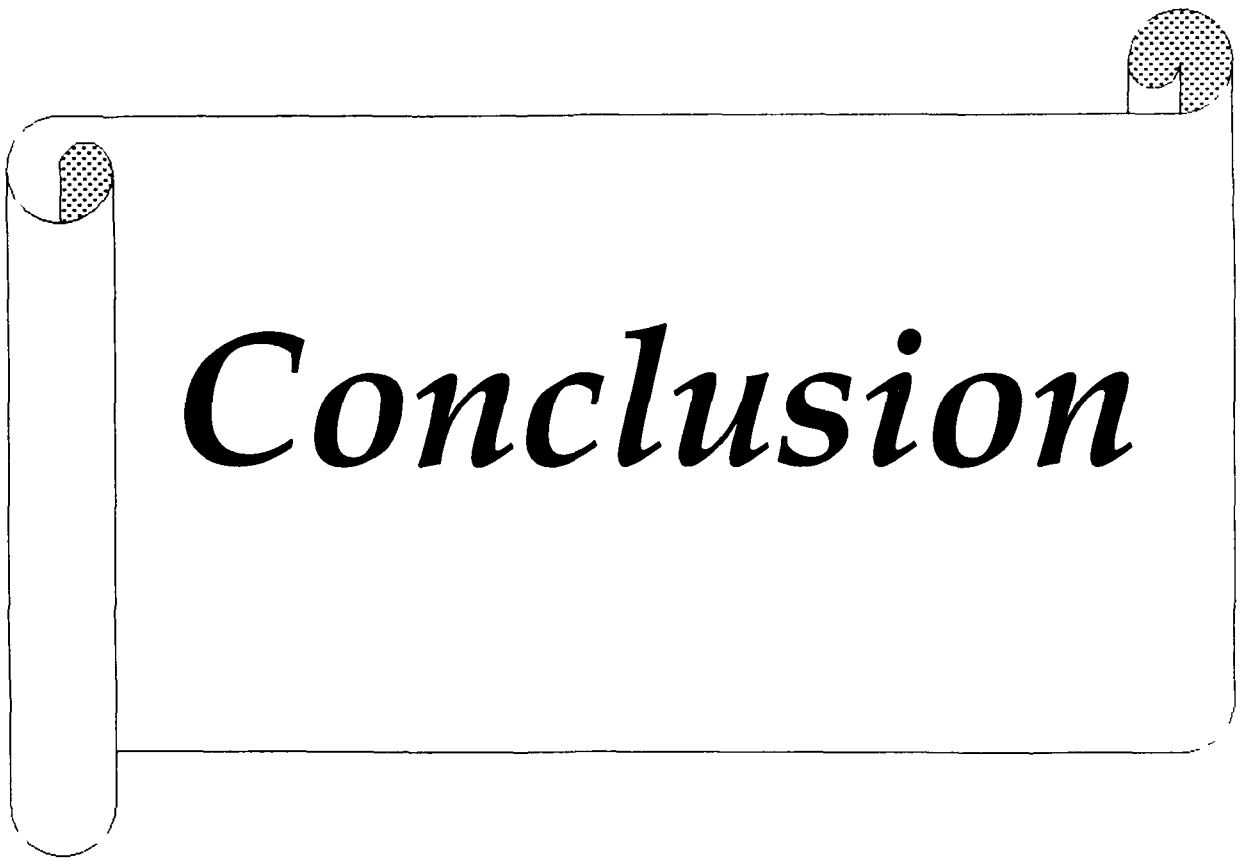
Total no. of Authors = 1831

Half of scientific papers = 503

Square root of total authors = $\sqrt{1831} = 42.77$

$\cong 43$

From analysis we get that 43 authors have contributed 419 papers which is approximately equal 41% whereas 50% would be 503 which is given by law. This law can not be exactly proved because of multiple authorship pattern which largely prevails now - a - days.


Conclusion

CONCLUSION

Bibliometric study has been done on the topic ***'Global Warming'*** of the period (1992 - 2001). The analysis is done at two different levels. Level - 2 gives the core journal of the subject, the most productive authors, most dominant language and most productive country. Level -2 gives the most cited journal and the most cited authors. Application of laws has been done. On the basis of bibliometric analysis the following results have been found out.

TOP THREE

RESULT OF LEVEL-1

A) Most productive authors

(i) **F. Ian Woodward** with 21 articles at first position.

(ii) **Syukoro Manabe** with 18 articles at second position

(iii) **Jorge L. Sarmiento** with 14 article at third position

B) Most productive journals

(i) **Climatic Change**- 72 articles at first position.

(ii) **Nature** -51 articles at second position.

(iii) **Science** - 42 articles at third position.

C) Most productive countries

(i) **USA** with 298 articles, 29.62% at first position.

(ii) **UK** with 119 articles 11.82 % at second position.

(iii) **Canada** with 81 articles, 8.05 % at third position.

D) Most used languages

(i) **English** with 883 articles , 87.77 % at first position.

(ii) **Japanese** with 39 articles, 2.58% at second position.

(iii) **German** with 26 articles, 2.58 % at third position.

RESULT OF LEVEL-2

A) Most cited authors

(i) **Syukoro Manabe** with 25 times is the most cited authors.

(ii) **J.T. Houghton** with 20 times is the second most cited authors

(iii) **P.D. Jones** with 17 times is the third most cited author.

B) Most cited Journals

(i) **Nature** with 88 times is the most cited journal.

(ii) **Climatic Change** with 57 times is the second most cited journal.

(iii) **Science** with 56 times is the third most cited journal.

FINDINGS

After going through the results of Level-1 & Level-2 literature, it is found that the journals used by the scientists on the topic ***'Global Warming'*** are not similar at the two levels. In Level-1 **'Climatic Change'** comes on the top as the most productive journal but it is at the second rank in Level-2. In Level-2 **'Nature'** comes on the top but **'Climatic Change'** is at the second rank.

Similarly in case of authorship ranking pattern shows that most productive author(s) are not the most cited one. For e.g. in Level-1 **F. Ian Woodward** is the most is the most productive author with the rank first followed by **Syukoro Manabe** and **Jorge L Samiento** with 2^{nd} and 3^{rd} respectively but in Level-2 **Manabe Syukoro** is the most cited author followed by **J. T. Houghton** and **P. D. Jones** at the 2^{nd} and 3^{rd} respectively and **F. Ian Woodward** (most productive of Level-1) and **J. L. Sarmiento** (2^{nd} ranked author of level-1) are ranked 5^{th} and 7^{th} in Level-2.

An obvious finding is that quantity and quality do not always coincide, as it is seen that the most productive journal as well as the productive author i.e. the ones which have the largest quantity are not the most cited, i.e. qualitatively they are not he best.

So in the end it is observed that the study at both the levels gives us a picture which tells us somewhat about the nature and characterstics of the journals and authors who are engaged in producing papers on ***'Global Warming'***. But at the same time it would be wise to mention some of its limitation that one encounters mainly in Level-2, as only few journal are taken for citation analysis there is always a chance of wrong findings specially in the case of journals as it is being observed that every journal has more of its citations than of others and if any author contribute a paper in a particular journal than it may not be cited in another journal and in case that journal is not taken up for citation analysis then there is always a chance of missing of that author in the citation analysis and in the process it will give somewhat skewed results.

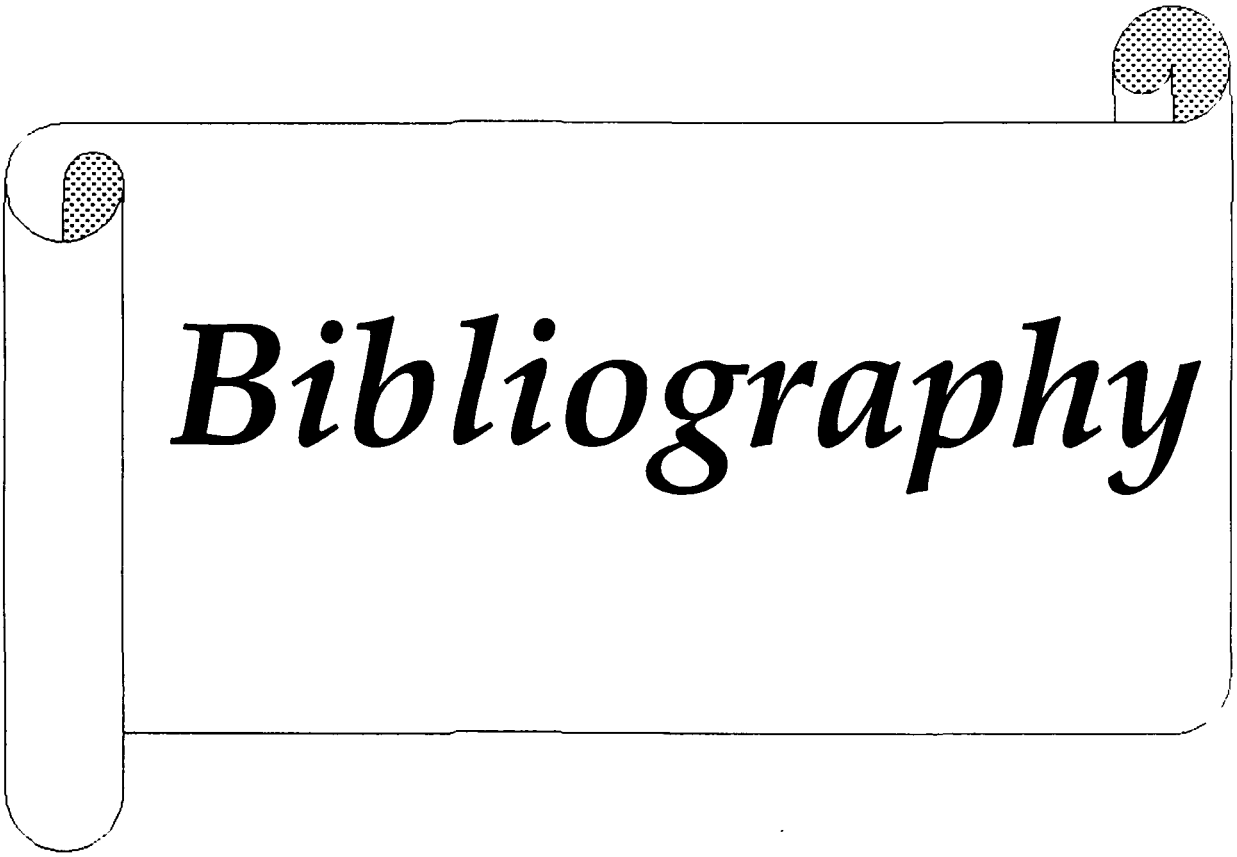
Regarding the laws of bibliometrics out of four main laws were studied.

Lotka's Law could not be proved may be because of the prevalence of multiple authorship.

Zipf's Law could not be applied because it refers to counting of words in long textual matter.

Bradford's Law was studied and it was proved. The total journals were divided into three zones. All the three zones give approximately equal no. of articles though the no. of journals increased from zone 1 to zone 3 which is what Bradford's Law says.

Price Square Law was also studied, this law is neither proved nor disproved.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WEB LINKS

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2. **http://www.nationalceter.org/kyoto.html**
3. **http://www.ngdc.noaa.gov/paleo/paleo.html**
4. **http://www.gcrio/index.html**
5. **http://www.ucsusa.org/org/environment/Owarming.html**
6. **http://cdiac.esd.ornl.gov/pns/faq.html**